LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING

A report from Maj. W. P. Craighill, Corps of Engineers, of a survey with a view to the construction of a ship-canal to connect the waters of Delaware and Chesapeake Bays.

JANUARY 12, 1880.—Referred to the Committee on Commerce and ordered to be printed, with accompanying documents.

WAR DEPARTMENT,
Washington City, January 10, 1880.

The Secretary of War has the honor to transmit to the United States Senate a letter from the Chief of Engineers, dated the 8th instant, and accompanying copy of report from Maj. W. P. Craighill, Corps of Engineers, of a survey made on the peninsula of Maryland and Delaware, in compliance with the requirements of the river and harbor act of June 18, 1878, with a view to the construction of a ship-canal to connect the waters of Delaware and Chesapeake Bays.

ALEX. RAMSEY,
Secretary of War.

The PRESIDENT
Of the United States Senate.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., January 8, 1880.

SIR: To comply with provisions of the river and harbor act of June 18, 1878, I have the honor to submit herewith a copy of a report to this office from Maj. William P. Craighill, Corps of Engineers, of the results of surveys made under his direction on the peninsula of Maryland and Delaware, with a view to the construction of a ship-canal to connect the waters of Delaware and Chesapeake Bays.

Very respectfully, your obedient servant,

H. G. WRIGHT,
Chief of Engineers, Brig. and Bv't Maj. Gen., U. S. A.

Hon. ALEXANDER RAMSEY,
Secretary of War.

SURVEYS WITH A VIEW TO CONSTRUCTION OF A SHIP-CANAL TO CONNECT THE WATERS OF THE DELAWARE AND CHESAPEAKE BAYS.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., November 18, 1879.

SIR: The construction of a canal to connect the waters of Chesapeake and Delaware Bays is by no means a new subject. There is one which has been long in use joining the Chesapeake, by way of Back Creek and Elk River, and the Delaware River at Delaware City. The construction of this canal was begun in 1824 and the water was let in July 4, 1829. The total cost was $2,250,000, of which one-fifth was paid by the United States, $100,000 by the State of Pennsylvania, $50,000 by the State of Maryland, and $25,000 by the State of Delaware, the remainder by citizens of the three States. The canal is 13⅝ miles long; width at water line, when constructed, 66 feet; width at bottom, 36 feet; depth of water, 10 feet; depth of excavation at summit, 75 feet; length of locks originally, 100 feet, since extended to 220 feet, and the width increased from 22 to 24 feet. The canal has a tide-lock proportioned for a use of 6 feet above low-water at Delaware City, a lift-lock of 16 feet at Saint George's, and a lock of 16 feet lift descending into Back Creek on the Chesapeake side. The summit level, about 10 miles long, is supplied by pumps at Back Creek. The average cost of pumping is about $12,000 annually; cost of maintenance and management, including all expenses, about $50,000 per annum.

This canal came to be deemed insufficient for the objects which a canal connecting these great bays should subserve.

In 1871 the National Commercial Convention in session in this city resolved:

> That Congress be memoralized to direct a survey to be made between the Chesapeake and Delaware Bays for the proposed improvement, and, if found to be practicable, desirable, and valuable to the great interest of the country, that the said ship-canal be constructed.

On the 11th of March, 1872, the following resolution was adopted by the United States House of Representatives, on motion of Hon. Thomas Swann:

> *Resolved*, That the Secretary of War be requested to communicate to Congress any information he may have upon the subject of the construction of a ship-canal from the waters of the Chesapeake to the waters of the Delaware Bay, and to state how much time would be saved by such improvement in the passage of ships from Baltimore to and from Liverpool and other foreign ports, and whether the building of such canal would not materially advance the interests of commerce.

A report was made from this office under date of March 25, 1872, giving an estimate of the cost of such surveys as were considered necessary, and containing a number of facts relative to the importance of the canal. This report was published in the annual report of the Chief of Engineers for 1872, beginning at page 701. A copy is appended hereto.

In 1872 a company was incorporated by the legislature of Maryland, called the Maryland and Delaware Ship-Canal Company. The legislature of Delaware also gave a charter to the same company. Copies of the laws are herewith.

The route selected by this company is that which joins Chesapeake Bay by the way of Sassafras River, and reaches the Delaware at or near Liston's Point. This line is only about 10 miles south of the existing canal described in the beginning of this report. This route has been re-

ported upon by the late Mr. B. H. Latrobe, of this city, and by Mr. W. Cullen Brown. Copies of these reports are herewith, dated, respectively, July 4, 1874, and March 1, 1878. A report is also inclosed, dated October 7, 1872, made by Mr. Julius Stahl. Thanks are due to Mr. H. B. Tebbetts, president of the company, for courteously furnishing these reports, as well as maps for use in comparing the different routes.

The river and harbor bill of 1878 contained directions for the survey of a route for a ship-canal to connect the waters of Chesapeake and Delaware Bays. A preliminary report was made February, 1879, which has been printed in Executive Document 91, House of Representatives, Forty-fifth Congress, Third Session, and in the annual report of the Chief of Engineers for 1879.

The surveys were conducted under the personal supervision of Mr. N. H. Hutton, commenceing in August, 1878, and closing in January, 1879. Borings were also made at a number of points in the peninsula, in order to determine the character of the soil through which the canal would pass. Mr. Hutton's report, dated September 20, 1879, is herewith.

The survey was a thorough one, as the details of the report and the maps show. It covered all the routes along which a canal was likely to be constructed except the Sassafras River route. The country is generally low and presents much sameness in many of its topographical features. I went over much of it in person, though taking no part in the instrumental survey.

The Sassafras River route was not surveyed, because the funds available became exhausted, and because there were in existence a project and estimate for it by Mr. Latrobe, already referred to. In the estimates, &c., herewith, Mr. Latrobe's data, with revised prices, have been used. As it has lately become practicable to survey that route also, parties are now in the field upon it. A supplemental report will be shortly made, containing the results of their work.

It is proposed to have a canal of the same level throughout without locks, except tide-locks, and these will propably be generally open and only exceptionally used. The time and height of the tides vary on the Chesapeake and Delaware sides and in some of the streams utilized in the several locations. The time of high-water on the one bay coincides about with low-water on the other, and *vice versa*. The average range on the Delaware side is about 4 feet within the limits surveyed, or twice as great as on the Chesapeake side.

The estimates are for a canal 100 feet wide at bottom, 26 feet below mean low water. The width is to be 178 feet at low water. The locks are to have chambers 600 feet long, 60 feet wide.

Estimates are also submitted for a smaller canal of 15 feet depth at mean low water. In the comparison of the costs of the several routes the figures refer to the larger canal described. These estimates are all full and liberal. It is possible a reduction in the width is compatible with easy use of the canal.

Six routes are estimated for which may be referred to by the names and numbers given in the table below, and they are shown on the accompanying small map of the country which was covered by the surveys. The name of each is taken from some distinctive topographical feature of the route.

All the routes are described in detail in Mr. Hutton's report. The lengths given are respectively from Baltimore to a common point at sea, 12 miles outside of the Delaware breakwater. The distance from Baltimore by the route now used to the same point is 325 miles, or 33¼

hours, allowing a speed of 10 miles in open water and 7 miles in dredged channels.

Number.	Names.	Length in miles.	Length of canal proper, or of excavation generally above low water.	Cost in millions of dollars.	Relative time of transit in hours, allowing 10 miles per hour in open water, 7 miles in dredged channels and 5 miles in canal proper.	Saving in time, in hours.	Saving in distance, in miles.
1	Choptank	149.81	37.67	$16\frac{1}{2}$	$19\frac{1}{2}$	$13\frac{3}{4}$	175
	Choptank (inland,)	138.91		$18\frac{1}{4}$	18	15	186
	Choptank, including Broadkill		30.00				
2	Wye	128.42	42.99	$26\frac{1}{2}$	$17\frac{3}{4}$	$15\frac{1}{2}$	$196\frac{1}{2}$
3	Queenston	107.29	53.78	$37\frac{1}{4}$	17	$16\frac{1}{4}$	$217\frac{3}{4}$
4	Centreville	106.38	50.95	$41\frac{1}{2}$	$16\frac{1}{4}$	$16\frac{3}{4}$	219
5	Southeast Creek	115.78	38.35	25	$15\frac{3}{4}$	$17\frac{1}{2}$	$209\frac{1}{4}$
6	Sassafras	129.25	16.20	8	$15\frac{1}{10}$	$18\frac{1}{10}$	$195\frac{3}{4}$

Mr. Hutton has pointed out the relative advantages and disadvantages of the several routes. A very formidable objection to the more northern routes would be the necessity of maintaining a deep channel directly across the natural set of the currents of Chesapeake Bay, where it would be almost certainly filled rapidly by the profuse sedimentary deposit to be expected there. Experience with the lower end of the Brewerton Channel has taught an important lesson in that direction. This would be very expensive if practicable. This difficulty led to the abandonment of the line of the old ship channel and to the opening of the new channel south of the 7-foot knoll. The attempt to cross the bay off the mouth of the Patapsco and to navigate it north of that point during the periods of fast and running ice would be next to impossible even with the use of ice-boats, whereas the approaches to the Choptank route are in the direction of the existing navigation and usable at all times.

Objection has been raised as to the presence of quicksand and the difficulty that would ensue in the construction and maintenance of the canal. Much of this objection was based upon the belief that great trouble had arisen from this cause in constructing the existing Chesapeake and Delaware Canal mentioned above.

Mr. A. C. Gray, president of that canal, and thoroughly conversant with its history, states that no quicksand was found in its construction, and that what difficulty has arisen in its maintenance has been due to other causes. He says there has been serious trouble from land-slides, though none have occurred for about ten years. These slips are due to the percolation of water between the inclined strata of the various clays and muds cut through, causing one layer or stratum to slide over the lower one. In one place the top width of the cut was increased from 360 to 800 feet in a depth of 75 feet. The excavations were generally through blue clay and black mud.

On the eastern end of the canal where it passes through the marshes of Saint George's Creek, for many years the berme and tow-path embankments sunk through the marsh. Mr. Gray states—

That large sections of embankment sunk 100 feet below the adjoining surface, and the bottom of the excavation rose 40 feet above its natural position.

GENERAL MAP OF PENINSULA.

TO ACCOMPANY REPORT OF

MAJ. W. P. CRAIGHILL. CORPS OF ENGRS. U.S.A.

ON

SHIP CANAL.

Scale 1/800,000

BALTIMORE

SASSAFRAS ROUTE.

S.E. CREEK ROUTE.

DOVER

CENTREVILLE LINE.

QUEENSTOWN ROUTE.

QUEENSTOWN.

WYE RIVER ROUTE

SKIPTON

MILFORD

DELAWARE BAY.

Cape May

Cape Henlopen.

MILTON

LEWES.

Choptank River

Choptank Route.

SEAFORD

SEOY. CREEK ROUTE.

CAMBRIDGE

FERRY CR. ROUTE

WALNUT LANDG

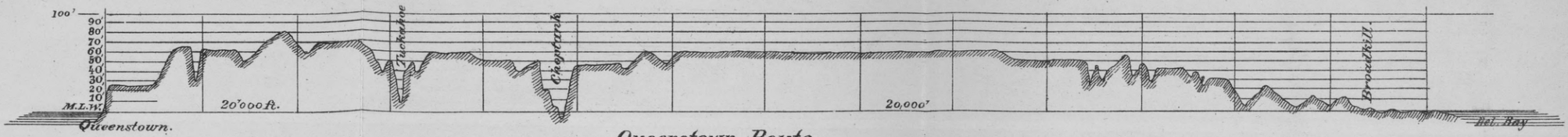
Pocomoke River

Potomac River.

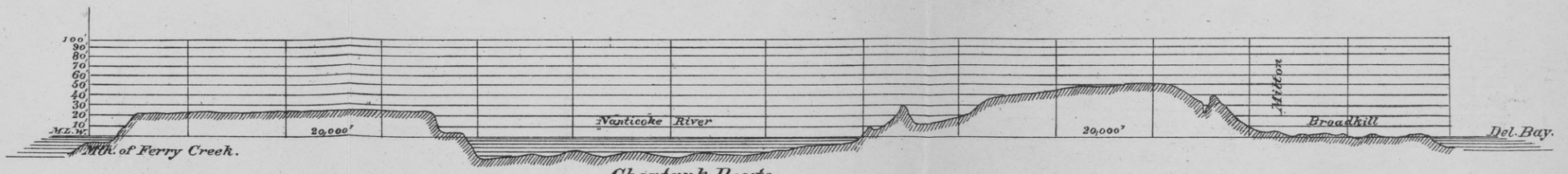
CHESAPEAKE BAY.

ATLANTIC OCEAN

1_S.Ex. 39.

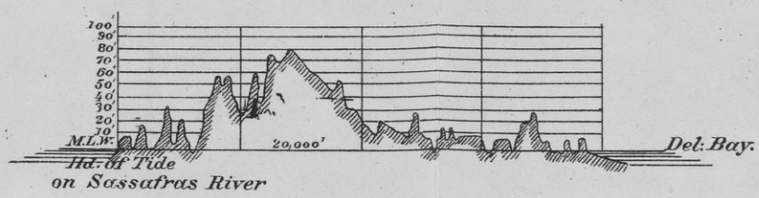


Queenstown Route.



Choptank Route.

Chesap'ke & Delaware Ship Canal.
Profiles of
Three (3) principal Routes.



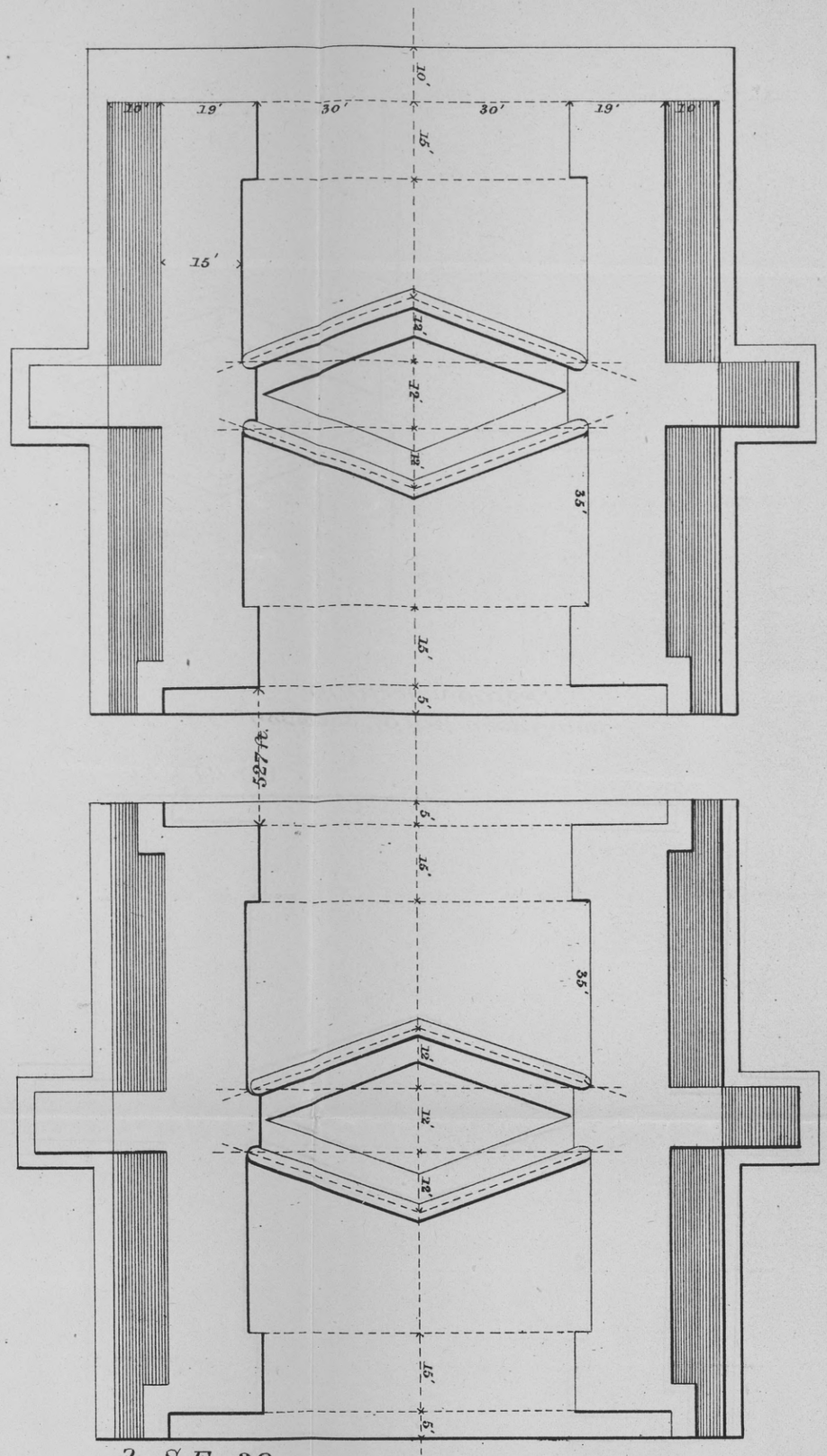
Sassafras Route.

Note: About four(4) squares or 80,000 ft. should be added to Sassafras Route to allow for heavy dredging up river of that name. In this sketch profile of N.Y. Co. has been followed

2-S. Ex. 39.

C. & D. Ship Canal. *Plan of Gate Chambers of Locks.*

Scale, 1 in. to 30 feet.

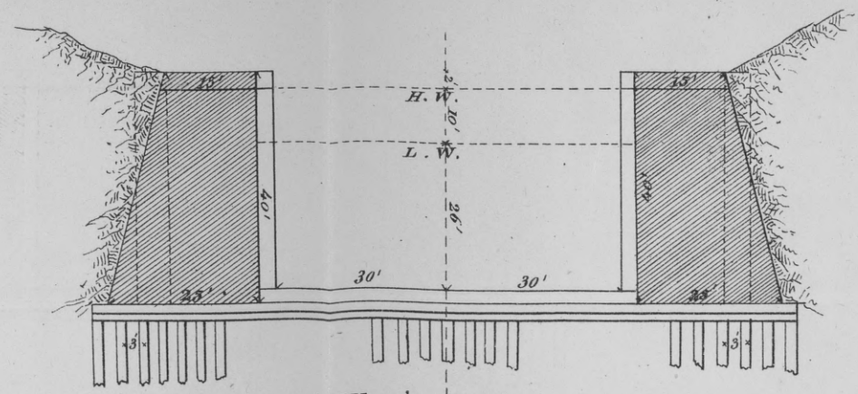


3_S. Ex. 39.

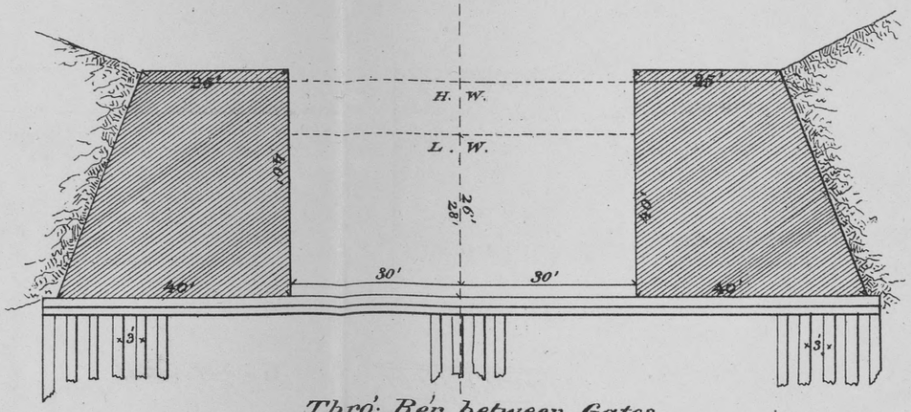
Lock for 26 feet deep Canal.
600 feet by 60 feet.

C. & D. Ship Canal. Sections of Lock Walls.

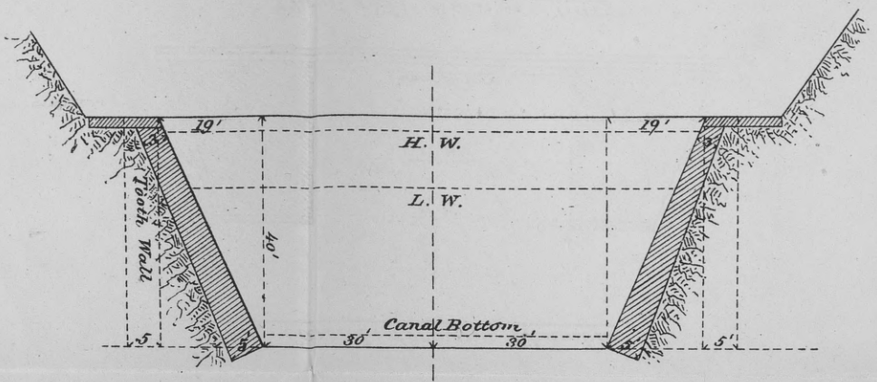
Scale 1 in: to 30 ft.



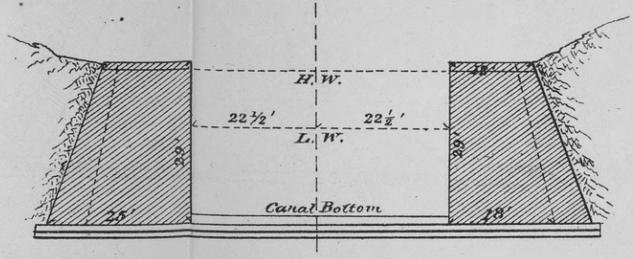
Thro': Recess.



Thro': Rer between Gates.

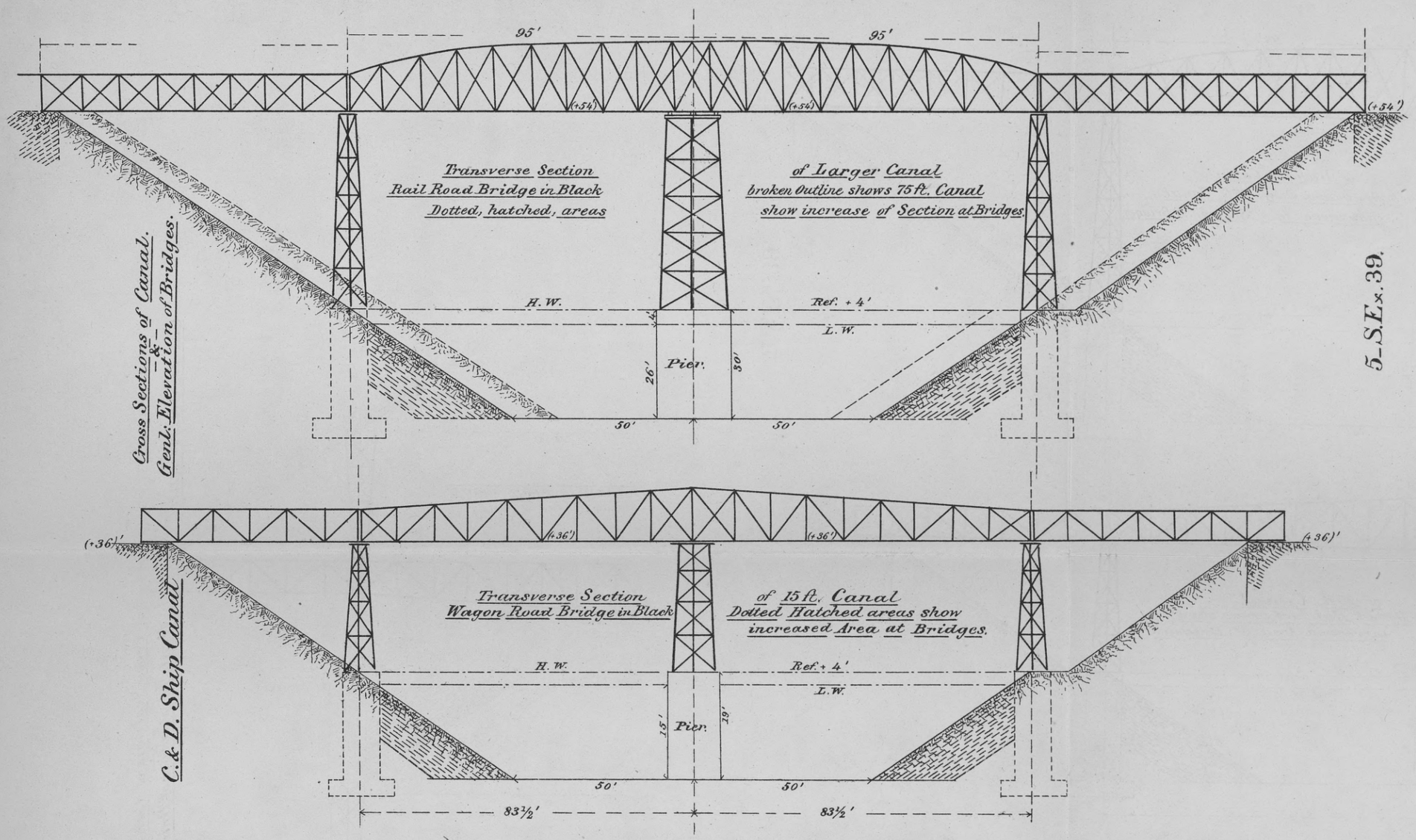


Thro': Canal, forming Chamber.



Thro': pier between Gates
& thro: recess in Dotted lines.
for
15 ft: Canal.

4-S. Ex 39.


95'
95'
(+54')
(+54')
(+54')
Transverse Section
Rail Road Bridge in Black
Dotted, hatched, areas
of Larger Canal
broken Outline shows 75ft. Canal
show increase of Section at Bridges.
H.W.
Ref. + 4'
L.W.
26'
Pier.
30'
50'
50'
Gross Sections of Canal.
—&—
Genl. Elevation of Bridges.
(+36')
(+36')
(+36')
(+36')
Transverse Section
Wagon Road Bridge in Black
of 15ft. Canal
Dotted Hatched areas show
increased Area at Bridges.
H.W.
Ref. + 4'
L.W.
15'
Pier.
19'
50'
50'
C. & D. Ship Canal
83½'
83½'

5-SEs. 39.

No such difficulty need be anticipated on the proposed Chesapeake and Delaware Bays Canal, as no hurtful artificial embankment would be permitted near the edge of the cut.

Objection has also been made that the canal could not be used at night, and the experience on the Suez Canal is brought forward to substantiate the objection. With reference to this point I quote from a letter received from a very intelligent engineer who has been through the Suez Canal. He says:

> You are aware that except at passing places the canal is only of single-track width in the deeper cuttings, and was barely excavated to the proper depth, making it necessary for the ship to follow accurately the center line, if of heavy draught. The grounding of a ship in so narrow a canal is a serious matter. If the Suez Canal was as wide throughout as it was (when I was there) through Lake Mareotis, where the cutting is light, and was well lighted, I can see no reason why it should not be used at night.

But the width of the proposed Chesapeake and Delaware ship-canal would be ample to allow vessels to pass each other everywhere, and there appears no good reason why it should not be used securely at night.

The importance of the canal becomes the more obvious when we consider not so much its usefulness to Baltimore locally as to Baltimore the outlet of many States of the great West. The canal would shorten distance not only for vessels crossing the ocean, but also for coasters.

Baltimore is interested in thus having a better connection with eastern and northern ports. The advantage is reciprocal.

No argument is necessary to show the great value, in time of war with a maritime power, of such an interior line of communication between the great Chesapeake and Delaware Bays and their tributary streams, as this canal would be.

But it is unnecessary to dwell upon the advantages of such a work. They are quite extensively set forth in the appended papers, and will no doubt be fully discussed in the report of the special committee of the House of Representatives.

Several sheets of drawings on a small scale are attached, as follows:

1. General map of peninsula, showing routes surveyed.
2. Profiles of Queenstown, Choptank, and Sassafras routes.
3. Plan of gate-chambers of lock.
4. Sections of lock-walls.
5. Section of proposed canal prism showing general arrangement of bridges, &c.

Very truly, your obedient servant,

WM. P. CRAIGHILL,
Major of Engineers.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

REPORT OF MR. N. H. HUTTON, ASSISTANT ENGINEER.

BALTIMORE, *September* 20, 1879.

DEAR SIR: I have the honor to submit the following report upon the surveys made under your direction to determine the cost of constructing a ship-canal connecting the waters of the Chesapeake and Delaware Bays.

During the last week in August, 1878, two parties of engineers were organized and put in the field, and continued the surveys of the several routes proposed, until the first week in January, 1879. A hydrographic party was also engaged during several weeks on the survey of the Nanticoke River, and Ferry and Secretary Creeks.

For the hydrography of the other rivers, creeks, and bays, recourse was had to the work of the Coast Survey, and of the Engineer Department.

Tide-gauges were established near both bays, and on the Nanticoke, on or adjacent to the termini of the several lines, and records kept of the tides for periods varying, at the different stations, from 16 to 70 days. The zeros of these gauges were connected by level lines, and all of them referred to the established plane of low water, at the iron pier near Lewes, Del.

During October a light boring apparatus was procured to determine the general character of the material to be encountered in the excavations for the canal on the three more prominent routes.

This work was stopped by cold weather in December, and was not completed until July, 1879.

The borings extended down to 26 feet below low water. Eleven holes were sunk, aggregating 817 feet in depth, or an average of 74¼ feet per hole.

About 240 miles of transit and level lines were run in connection with the routes examined, and at least 100 miles additional of level lines were run in the test lines between the bays, and to connect the several gauges. Records of tides were kept daily at Secretary Creek (Choptank), Walnut Landing, and Seaford, on the Nanticoke, during periods varying from 60 to 90 days, and during periods of two weeks at Lewes, Milford, and Blackbird, on the Delaware side, and at Queenstown and Georgetown, on the Chesapeake side.

The limited allotment of money for this work has somewhat delayed the preparation of the results of the field-work.

The peninsula which it is proposed to pierce for a ship-canal has (within the limits embraced by these surveys), a width across the lower end (from the mouth of the Choptank River to Cape Henlopen) of about 56 miles, diminishing at the upper end (from the mouth of the Sassafras River to Liston's Point), to about 28 miles; the extreme difference of latitude between these points being about 71 miles.

It is traversed longitudinally by two large tidal estuaries, rather than rivers; the Choptank running southerly, nearly parallel to, and distant 10 and 20 miles from, Chesapeake Bay; and the Nanticoke, which heads within a few miles of Delaware Bay, above Lewes, runs nearly southwest to the forks at Walnut Landing, and thence nearly south to the Chesapeake Bay. Both of these streams are navigable for large vessels for at least 50 miles of their lengths.

The Nanticoke at Walnut Landing is less than 15 miles from the Choptank River, at the mouth of Ferry Creek, while its head is but 5 or 6 miles from the Broadkill Creek, which empties into the Delaware Bay, 3 miles above the breakwater. The lower route surveyed is intended to utilize these topographical advantages.

The Chesapeake Bay is penetrated on its eastern shore by several wide and deep estuaries, trending easterly toward Delaware Bay. Principal among these are the Saint Michael's, Wye, Chester, and Sassafras Rivers, all of which have at times been brought forward as offering facilities for the construction of a ship-canal connecting the two bays.

The Chesapeake is generally characterized by bold water close to either shore, which are elevated from 10 to 50 feet above the water, and its estuaries present the same general features.

The Delaware Bay, on the contrary, has wide shoals separating its western shore from deep water, while the shore from Cape Henlopen to Liston's Point presents an almost unbroken marsh, several miles in width, much of it overflowed at high-water, and none of it more than 4 feet above low-water. Its tributary streams are small and unimportant, owing to the proximity to Delaware Bay of the crest of the water-shed between the bays. Owing to the extensive shoals referred to, the debouch of a ship-canal into Delaware Bay, can only be economically and safely located at such points as the width of shoal water is greatly less than the average.

The surface of the peninsula rises gradually from an average height above low water of about 30 feet, on the lower route surveyed, to an average exceeding 70 feet above on the upper route. The country changes its levels so gradually that throughout the peninsula, the general characteristic is flatness. The streams, even of the larger size, have no valleys, properly socalled, but rather seem to flow through gashes worn by the waters through the flat land, with side slopes rarely extending more than a few hundred feet on either side.

The borings indicate that the peninsula, is, geologically, of the most recent formation; deposits of sand, gravel, clay and mud, alone being encountered with the exception of a deposit of marl, which was bored into in the vicinity of Queenstown, Md., and which is said to extend through a large portion of Talbot and Queen Anne Counties, and has been penetrated to a depth of over 300 feet at Centreville in the last-named county.

A section, parallel to the Chesapeake and ten to fifteen miles east of it, shows a deposit of sand and gravel, from 20 to 30 feet in thickness, underlaid by strata of hard mud and clay; under which (on the Queenstown line only), is found the marl, before referred to. The upper surface of the clays in this section, is about 11 feet below low-water at the lower end, and rises to 40 feet above at the upper end.

A similar section, nearly parallel to the Delaware Bay, and fifteen to twenty miles west of it, shows a much greater thickness of the deposits of sand and gravel, particularly toward the lower end of the peninsula, where they attain a depth of over 70 feet, which diminishes to 25 feet at the upper end. On this side as on the other these deposits are underlaid with hard clays and mud, whose upper surface rises from 20 feet *below* (at the lower end), to 6 feet *above* low-water, at the upper end of the section.

Among the various kinds of sand encountered in the borings, some possessed many of the characteristics of "quick-sand"; but as in all cases the sand grains, though fine, were sharp, and well defined, it is believed that they were simply saturated with water, which would drain off when an opportunity was afforded.

The drainage area of the peninsula, which is not large in the aggregate, and is entirely porous as to soil, is so cut up by the Nanticoke, Choptank, Wye, Chester and Sassafras Rivers, and their branches, that no one of them receives rain-water in sufficient quantities to give it any importance of volume or size; that which they have, being entirely derived from the tidal flow. This being the case, and coupled with the flatness, and porosity of the surface freshets of great height or velocity of current, are not to be expected. The best information attainable from residents along these streams limits the heights of floods to 4 or 5 feet; and as they always occur when heavy rains are in conjunction with high winds blowing in a direction to retard the flow of ebb-tide, the water must necessarily be almost slack as to current.

It may be generally inferred from the foregoing description that this peninsula offers the following facilities for the construction of a water-way across it.

The materials encountered could be easily and cheaply excavated, though they would generally require flat side slopes in all cuts.

Sufficiently good foundations for all mechanical structures, can be obtained in the hard clays. Any of the streams can be safely crossed, at tide level or followed and used as a part of the canal, without danger or obstruction from freshets. The limited area of the water-shed, the extent to which it is subdivided by the many streams, and the entire absence of well-defined valleys to any of them; in connection with the flat, porous character of the surface throughout the peninsula, preclude the idea of overcoming by lift-locks any portion of the elevation of the land between the bays, as a summit supply of water could not be obtained; nor could it be economically and safely impounded, even did the water-shed afford a sufficient amount.

ROUTES EXAMINED.

As your instructions contemplated the examination of all routes that had been or were likely to be brought forward as either practicable or economic, surveys were made of five lines, which, with the Sassafras route (previously examined and reported upon by the late Mr. B. H. Latrobe, and therefore not embraced in these surveys) made six routes for a ship-canal across the peninsula, upon which sufficient data have been collected to determine the merits of the several routes, as well as the possibilities for any of them. Commencing at the more southerly one, the routes may be briefly distinguished, as:

No. 1, or Choptank route.
No. 2, or Wye River route.
No. 3, or Queenstown route.
No. 4, or Centreville route.
No. 5, or South East Creek route.
No. 6, or Sassafras route.

Lines Nos. 1, 3, and 4 have the same objective points on the Delaware Bay, that is, the mouth of the Broadkill, 3 miles above the Breakwater. Nos. 3 and 4 are, moreover, "air-lines," or nearly so, between the bays. They enter the peninsula by the way of the Choptank and the Chester Rivers, respectively.

No. 2 enters by way of the Wye River, on the Chesapeake side, and terminates at the mouth of the Mispillion Creek, on the Delaware side.

No. 3 enters by way of Chester River, and terminates at mouth of Little Creek, on the Delaware, passing through Dover, the capital of Delaware.

No. 1, or Choptank route, leaves the Choptank about 25 miles above its mouth (5 miles above Cambridge, Dorchester County), passes up Ferry Creek, through a marsh, and over a flat country, about 25 feet above "low-water," to the Nanticoke River, at Walnut Landing (about 15 miles from the Choptank); thence up that stream and its drainage to the "divide"; and thence down the Broadkill and its marshes to its mouth, about 3 miles above Lewes, Del. The Nanticoke for 12 miles has a width of from 500 to 700 feet, and depths of from 20 to 12 feet of water; and for 4 miles additional a width of from 50 to 100 feet, and a depth of from 10 to 6 feet; thence to the summit, the line passes over a flat, sandy, and swampy country, heavily timbered, and about 30 feet above low-water, for a short distance crossing the "divide" an elevation of 50 feet is encountered, but this soon falls off to 30 and 35 feet; and thence to zero, on the Broadkill at Milton. In connection with this route, two other

lines were surveyed; the one leaving the Choptank at the mouth of Indian Creek (2 miles above Ferry Creek) and striking the Nanticoke at the same point (Walnut Landing). The other left the Choptank at the mouth of Secretary Creek (5 miles above Ferry Creek), passed up that stream to its head; thence in an air-line to the Nanticoke at Cannon's Ferry (9 miles above the forks at Walnut Landing), crossing the northwest branch of the Nanticoke at Heckett's Wharf. The first line (by way of Indian Creek) has not been considered in this report, for the reason that it was longer than by Ferry Creek, and on ground 5 or 6 feet higher; the second (by way of Secretary Creek) has also been omitted, for the reason that while it lessened the total distance, about 2 miles, it involved 2 miles more of excavation for canal prism than the Ferry Creek line, and was, throughout, over ground from 10 to 16 feet higher than the latter route.

No. 2, or Wye River route, leaves the Chesapeake at Eastern Bay, passes through that, and up the Front Wye to Skipton Creek, up that stream to the head of tide; thence in a nearly air-line 34½ miles over flat country, about 60 feet above low water, to Milford, Del.; and thence down the Mispillion, and through its marshes 8½ miles to Delaware Bay, 17 miles above Lewes, and 7½ miles from 24 feet water. This line crosses the Yuckahoe and Choptank Rivers where they are from 500 to 700 feet wide, and from 6 to 10 feet deep. Eastern Bay is wide and deep, as is the Wye, requiring only small amounts of dredging; Skipton Creek also requires only dredging to proper depth for a canal.

No. 3, or Queenstown route, leaves the Chesapeake at mouth of Chester River; passes up that river and Queenstown Creek to Queenstown, and thence over a country from 60 to 80 feet above low water, in an air-line, to the Broadkill Creek, 2¾ miles above its mouth (at Wiltbank's Landing); thence coinciding with the Choptank route, down that stream to the bay, 3 miles above Lewes.

No. 4, or Centreville route, leaves the Chesapeake 27½ miles from Baltimore, passes through a shallow gut in the peninsula forming the west bank of Chester River, (about 4 miles above its mouth), striking 24 feet water in the river about 1 mile from that depth in the bay, and saving nearly 8 miles over the route by the mouth of the Chester; thence it passes up that wide and deep estuary about 4 miles to Corsica Creek, and up that stream (having 4 to 6 feet depth of water in its shoalest portions), to the head of tide; thence over a flat country, from 60 to 75 feet above low water, to its junction with the Queenstown line, with which it coincides for 9 miles on the western end, and enters Delaware Bay about 51 miles from the head of tide-water in Corsica Creek.

No. 5, or Southeast Creek route, enters Chester River by the same line as for No. 4, passes up that river 12 miles to Southeast Creek, and up that stream (having 4 to 5 feet water) 2½ miles to the head of tide-water; thence in a nearly straight line over a a flat country 60 to 70 feet above low-water, about 29 miles, to Little Creek, down which, and at its adjacent marshes, it passes 3¾ miles to Delaware Bay, which it enters 30 miles above Lewes, and 5½ miles from 24 feet water in the bay. This line passes through the northern suburbs of Dover, and its debouch is a few miles below Mahon's River light-house.

No. 6, or Sassafras route, as located and described by the engineers of the company having State charters, passes up the Chesapeake 39½ miles from Baltimore to the mouth of the Sassafras River; thence up that stream to the head of tide water (16½ miles); thence over a country rising to 80 feet above low water and down the drainage of the Blackbird Creek until it trends northerly, when it passes over a ridge of high ground and enters Delaware Bay near Liston's Point, 14¼ miles from "head of tide" on the Sassafras, 1 mile from 24 feet water in the bay, and 46 miles above Lewes.

A detailed statement of the lengths of the several routes, from the city limits of Baltimore to a point at sea 12 miles outside the breakwater at mouth of Delaware Bay, would be as follows:

No. 1, Choptank:

	Miles.
Patapsco and Chesapeake Bay	53.91
Choptank River	25.03
Ferry Creek	1.51
Overland to Nanticoke	13.44
Up Nanticoke to Concord	14.77
Overland to Broadkill	16.66
Down the Broadkill	7.57
To 24 feet water in bay	3.78
To point at sea	13.14
Total	149.81
Or if "inland" route is used, as hereinafter described	138.91

No. 2.—Wye River:

	Miles.
Patapsco and Chesapeake	35.93
Eastern Bay, Wye and Skipton Creek	22.73
Overland to Mispillion Creek	34.47
Down Mispillion	8.52
To 24 feet water in bay	7.57
To point at sea	19.20
Total	128.42

No. 3.—Queenstown:

Patapsco and Chesapeake	24.81
Chester River and Queenstown Creek	11.78
Overland to Delaware Bay	53.78
To 24 feet water in bay	3.78
To point at sea	13.14
Total	107.29

No. 4.—Centerville:

Patapsco and Chesapeake	27.50
Over peninsula (Nilsen's Point)	1.14
Up Chester River	4.17
Up Corsica Creek	5.70
Overland to Delaware Bay	50.95
To 24 feet water in bay	3.78
To point at sea	13.14
Total	106.38

No. 5.—Southeast Creek:

Patapsco and Chesapeake	27.50
Over peninsula (Nilsen's Point)	1.14
Up Chester River	12.06
Up Southeast Creek	2.37
Overland to Delaware Bay	32.67
To 24 feet water	5.68
To point at sea	34.36
Total	115.78

No. 6.—Sassafras:

Patapsco and Chesapeake	39.69
Up Sassafras River	16.38
Overland to Delaware Bay	14.20
To 24 feet water	0.95
To point at sea	58.03
Total	129.25

SUMMARY.

Choptank route	149.81
Choptank route (inland)	138.91
Wye River route	128.42
Queenstown route	107.29
Centreville route	106.38
Southeast Creek route	115.78
Sassafras River route	129.25

The "inland" line referred to, for the Choptank route, which can be constructed at a cost of $870,000 over that of the longer line, saving about eleven miles of distance, proposes to enter the mouth of Chester River, and passing through Kent Island Narrows, Eastern Bay, and Miles River to Oak Creek, crosses a low peninsula, and down Plaindealing Creek and Third Haven, enters the Choptank at the mouth of the former estuary.

The length of canal proper, or of excavation generally, above low water is as follows for the several routes:

Choptank route, 37.67 miles, including Broadkill Creek; or

Choptank route 30 miles, excluding the Broadkill, through which excavation would be about half above and half below.

Wye River route, 42.99 miles.

Queenstown route, 53.78 miles.

Centreville route, 50.95 miles.

Southeast Creek route, 38.35 miles.

Sassafras route, 14.20 miles, counting all of the Sassafras as dredging, though it is probable that at least two miles of the upper part will class as the Broadkill, half canal and half dredging, which would make Sassafras route 16.20 miles canal as compared with 37.67 in the Choptank route.

PROJECTS FOR A SHIP CANAL.

The projects for a canal, for which estimates are herewith submitted, are based upon a system without locks other than those possibly to be required for the regulation of the tides, a system which, in addition to its manifest advantages in reducing the time of transit through the canal, is rendered necessary by the topographical features of the country, which prohibit the economic gathering of a water supply above the tide level, or the construction of reservoirs, even could the water be collected.

The observed records of tides, as mentioned before, indicate that for the two bays the periods of high water in the one nearly correspond with those of low water in the other, and that the range on the Delaware side averages 4 feet, while on the Chesapeake it is slightly less than 2 feet; whilst on the Nanticoke River another tidal movement appears, nearly coinciding with the Delaware tides as to range, and intermediate as to periods of high and low water between the tides of the two bays.

The greatest observed rise of the Delaware tides (as by records of Engineer Department) above mean low water was 8 feet at Lewes and 11 feet at Fort Delaware (some distance above the most northerly projected canal-route); both having occurred during the cyclone of 1878.

On the Chesapeake side, the greatest variation does not extend to more than 4 feet above mean low water.

By two carefully-run lines of test levels, the greatest difference between the planes of mean low water in the two bays did not amount to more than four-tenths of a foot; and they may be considered practically at the same level.

The effect of the varying movement of these tidal currents upon the stability and utility of the canal prism becomes an important question, and one difficult of accurate solution, owing to the uncertainty of predicting in advance the exact effect upon these currents within the canal prism to be produced by the connection of the several tides by a continuous water-way.

By reference to the appended diagrams of tides, showing the hourly movement on selected days on the two extreme routes, it will be seen that without any disturbance by storm or otherwise, it is highly probable that a bottom velocity may obtain for several hours amounting to 1¼ feet per second, which is about the limit of stability for fine sand, through which a large portion of the canal would be excavated on any of the routes; and, as a matter of course, the damage from this source, as well as that of retarding navigation, would be greatly increased during the prevalence of a storm which raised the Delaware tides and depressed those of the Chesapeake; a conjunction which has occurred, and of course may occur again.

Estimates have therefore been made for tide-locks on the Delaware Bay side, and wherever tidal streams are crossed, entered, or left. I am inclined, however, to the belief that it will be found that those estimated for the Nanticoke, and for the crossings of the Choptank and Tuckahoe Rivers, can be dispensed with.

The estimates contemplate simple, wide, open cuts leading into and out of the Nanticoke and other streams crossed or traversed, forming small basins, and provided with locks to regulate the tide or not, as may be found expedient; the vessels issuing from the canal proper will either pass up the stream or cross it, as the case may be, at its then level, and will enter on the opposite bank a basin of sufficient length and width to enable it to be safely entered against a cross-current, and to permit the vessel to be steadied and straightened up to pass on through the narrower canal.

The estimate for "approaches" on the Delaware side contemplate only parallel walls of riprap, say, 1,000 feet long, extending out from shore and inclosing the dredged channel between them for a sufficient distance to enable vessels to be steadied and straightened up for entrance to the canal.

No estimates have been made for harbors of refuge or basins at either end nor will they be required, if the present breakwater is extended and its harbor deepened.

The borings indicate that portions of all the routes will be in material varying in character and cost of removal; but as the exact or probable amount and extent of this

variation on any of the routes could only be determined by more exhaustive examinations than were required for a general scheme, no allowance on this account has been made in the estimates. The general result indeed is not affected, as the estimates are based upon flat slopes (1½ to 1) thoughout, and the smaller area of excavation needed, where slopes of less inclination could be used, would be counter-balanced by the increased cost of excavation of the harbor material.

The lower portion of the canal prism on the Choptank route will be in clay or hard mud; and the whole prism of the upper routes will be in marl, clay, or hard mud, except the central section of 10 or 15 miles of the Centerville, Queenstown, and Wye River routes, which would probably be in sand and gravel.

The determination in detail of the more economic methods of executing the works for this canal on any route would require careful study after a particular route was selected.

It may, however, be stated generally that all the routes examined offer great facilities for removing large portions of the excavated material by means of dredging machinery, in connection with scows or barges, which is acknowledged to be the cheapest method of handling large masses of excavation.

It would, therefore, seem proper to excavate to as great an extent as possible by these means, the excavated material being towed away by tugboats, and deposited in the shoal bays and creeks and on the marshes adjacent thereto, or, where required, deposited in the deep waters of either bay.

It is probable that by this means the whole of the canal prism proper, together with from 15 to 20 feet depth of cutting, above low-water level, could be removed at very low cost per cubic yard.

The material to be handled above this level would probably have to be removed by steam excavators and tram-ways, and deposited in spoil banks on either side of the cuts, but they (the spoil banks) should be kept at the lowest possible limit as to size both for the reason of the danger and inconvenience to be caused by them as for the increased expense of lifting material over its descent by gravity, and movement on a horizontal plane.

On the Choptank route, the Choptank, Nanticoke, and Broadkill Rivers offer four faces for the operation of dredges with an average haulage (or tonnage) of excavated material not exceeding 8 miles.

On the Wye, Queenstown, and Centreville routes the two bays and the Choptank and Tuckahoe Rivers offer six faces for operation, with not greater average towage than the Choptank route, while on the Sassafras route the river of that name and Delaware Bay present two faces only separated by about fourteen miles of land, much of it, on the eastern end, low and flat.

DIMENSIONS OF CANAL, ETC.

The estimates herewith embrace for all the routes a canal 100 feet wide at bottom, which is 26 feet below mean low water, with a width of 178 feet at low-water level, and a berme, 30 feet above bottom, 12 feet wide (on one side only), all slopes being 1½ to 1. The locks are estimated to be 60 feet by 600 feet in the chambers, and are intended to pass vessels drawing from 22½ to 23 feet. A memorandum also accompanies the estimates, showing approximate reduction of cost for this scheme, if the bottom width is reduced to 75 feet, making low-water width 153 feet, and also of the reduction, if, with 75 feet bottom width, the canal is reduced to 24 feet depth, and 147 feet width at mean low-water level.

The detailed estimates were made on the larger scale for the reason that it is thought the dimensions are those which will enable large vessels to pass each other without danger or delay, while the increase of two feet in depth over that obtained in the dredged channels and open waterways, is considered essential to the proper management of vessels in the comparatively contracted waterway of the canal.

Estimates are also submitted for the Choptank, Queenstown, and Sassafras routes for a canal 15 feet deep at mean low water, 100 feet wide at bottom, and 145 feet wide at low-water line, with a berme on one side, 19 feet above the bottom, and is intended to pass vessels drawing from 13 to 14 feet of water. The locks for this plan are proposed to be 45 feet by 300 feet in the chambers.

The dredged channels in connection with these routes are estimated to be 300 feet wide in all cases, with depths of 24 and 15 feet respectively, 24 feet being assumed for the larger canal, as the present ruling depth for Baltimore Harbor, which can readily be increased at any time to 26 feet, if required.

The question of providing means of transit over the canal, in a country so plentifully supplied with wagon-roads as is this peninsula, becomes a serious one, both as to cost and delay in passing vessels through the canal by reason of the frequent stoppages at the draws.

Were every road that crosses the projected lines of any of these routes to be provided with a drawbridge, it would seriously impede the navigation of the canal. Estimates,

therefore, have only been made for four road bridges on the Chesapeake line: One between Choptank and Nanticoke; one at Seaford and Milton each; and one between Concord and Milton.

On the Wye route, four; on the Queenstown and Centreville routes, five each; and on the Sassafras route, two bridges; to be distributed as may be hereafter determined, and making the distance between them on the several routes from 7 to 10 miles.

It is expected that any larger number of crossings can be made by ferries—to be provided by the neighborhoods using them.

MECHANICAL STRUCTURES.—LOCKS.

The drawings submitted herewith indicate the general character of locks proposed. They will consist of masses of masonry at either end, to receive the gates, connected by embankments (or an excavation in cuts) faced with stone, which will form the body of the lock chamber. The walls are proposed to be built of heavy masonry, founded on piles and a timber platform. As it is proposed to locate all locks on the higher ground adjacent to the marshes or streams, they will be in not less than 10 to 20 feet depth of excavation above low water, and guard banks will not be required. The side walls of all locks are estimated to be built to extend 1 foot above the height of the cyclone tide of 1878, or say 10 feet above mean low water. The thrust of the gates is supposed to be only that due to a depth of 26 feet of water, as it is assumed that the lock chambers will not be emptied during storms, or indeed, at any other than selected favorable times. The variations of locations will doubtless affect the height and cost of lock walls, but I have here, as in every other case, assumed the greatest quantity and cost possible as the probable cost and quantity.

The gates are proposed to be of wrought iron, and the prices are based on recent experiences in this direction; they may seem to be formidable affairs to operate when built, but it can be readily and economically done by the aid of hydraulic accumulators.

Owing to the fact that the main portion of the lock chamber is formed by a simple excavation or embankment, any required increase or diminution of the length of the chamber will not seriously affect the whole cost of the lock.

BRIDGES.

For both wagon and rail road crossings it is proposed to use wrought-iron bridges supported on wrought-iron piers above high-water mark. Each bridge would consist of a draw span, of a length equal to the high-water width of canal; and a fixed span at either end extending to the intersection of side slopes with level of road.

The sketches submitted with this show general arrangement proposed, the piers being of masonry up to high-water level (or at ref. + 4 feet).

The iron piers are proposed in place of masonry, as occupying less space, and avoiding any enlargement of canal section at site of central piers.

The wagon-road bridges can be shortened in most cases, by grading down their approaches on either side of canal, and the estimates contemplate in each case a reduction proportioned to a cut 20 feet deep at intersection with side slopes of canal.

The railroad bridges are estimated to cross at an elevation of 50 feet above high water.

SEA APPROACHES.

As before stated, the only approaches or protections estimated for are on the Delaware Bay side, as all the debouches on the Chesapeake side are in sheltered creeks or rivers, and on the Delaware consist simply of riprap jetties, running out from the shore line far enough to enable entering vessels to be "straightened up" for the canal, and are generally assumed at 1,000 feet in length, with an area of 30 square yards, when in 6 feet water.

ESTIMATES FOR MECHANICAL STRUCTURES.

Locks—600 by 60 by 40 feet:	
6,000 yards masonry, at $10 yer yard	$60,000
12,000 yards masonry, at $6 per yard	72,000
5,000 yards slope wall, at $4 per yard	20,000
4 double gates, at $10,000	40,000
600,000 feet of timber, at $30, laid	18,000
130,000 feet piling, at 15 cents, cut off	19,500
Total	229,500

Locks—300 by 45 by 29 feet:

4,000 yards masonry, at $10 per yard	$40,000
6,000 yards masonry, at $6 per yard	36,000
2,000 yards masonry, at $4	8,000
4 double gates, at $8,000 per set	32,000
400,000 feet timber, at $30, laid	12,000
80,000 feet piling, at 15 cents, cut off	12,000
Total	140,000

BRIDGES.

Railroad at elevation + 54 feet.
Draw span 190 feet long.
Fixed spans, 75 and 87 feet clear length.
Total, 360 feet.

450,000 pounds of iron, at 15 cents	$67,500
90,000 pounds iron, at 15 cents (in piers)	13,500
1,500 yards masonry in piers, at $6	9,000
Total	90,000

WAGON-ROAD BRIDGE AT ELEVATION, + 34 FEET.

Draw span 190 feet.
Fixed spans, 57 and 45 feet clear.
Total length, 300 feet.

250,000 pounds iron, at 15 cents	$37,500
45,000 pounds iron, at 15 cents (in pier)	6,750
1,375 yards masonry, at $6 (in pier)	8,250
Total	52,500

It may be remarked that the price for iron in these bridges is very high, but it is intended to cover all cost of transportation and erection, and includes the whole bridge complete.

ESTIMATED COST OF A SHIP-CANAL 26 FEET DEEP BELOW MEAN LOW-WATER, 100 FEET WIDE AT BOTTOM, WITH BERME (ON ONE SIDE) 12 FEET WIDE AND 30 FEET ABOVE BOTTOM—SLOPES 1½ to 1.

Ferry Creek route:

Excavation above high-water, 38,243,512 yards, at 20 cents	$7,648,702
Excavation between high and low water, 6,034,109 yards, at 15 cents	905,116
Excavation below low-water, 29,175,000 yards, at 12½ cents	3,646,875
Dredging in Delaware Bay to 24 feet depth, 2,100,000 yards, at 10 cents	210,000
Dredging in Nanticoke, 10,000,000 yards, at 10 cents	1,000,000
Dredging in Choptank and Ferry Creek, 860,000 yards, at 10 cents	86,000
Protection walls on Delaware Bay, 1,000 feet long, 20,000 yards, at $3	60,000
Piling across Lewes Creek, 3,000 feet, at $7	21,000
Road bridges, 4, at $52,500	210,000
Railroad bridges, 3, at $90,000	270,000
Tide locks, 3, at $229,500	688,500
Land damages, 3,500 acres, at $50	175,000
Ten per cent. for contingencies	1,492,119
Total estimated cost	16,413,312

Wye River or Skipton and Milford route:

Excavation above high-water, 80,821,865 yards, at 20 cents	$16,164,373
Excavation between high and low water, 4,988,444 yards, at 15 cents	748,267
Excavation below low-water, 32,462,478 yards, at 12½ cents	4,057 809
Dredging in Delaware Bay, 4,400,000 yards, at 10 cents	440,000
Dredging in Wye River, 5,000,000 yards, at ten cents	500,000
Excavation Bennet's Point, below low-water, 1,500,000 yards, at 12½ cents	187,500
Protection walls, Delaware Bay, 30,000 yards, at $3	90,000
Walling through Milford, 7,000 yards, at $10	70,000
Foundation for same, 60,000 square feet, at $1	60,000

Tide locks, 5, at $229,500	$1,147,500
Railroad bridges, 3, at $90,000	270,000
Road bridges, 4, at $52,500	210,000
Land damages, 3,900 acres, at $50	195,000
Ten per cent. contingencies	2,414,044
Total cost	26,554,493

Queenstown line:

Excavation above high-water, 128,356,000 yards, at 20 cents	$25,671,200
Excavation between high and low water, 7,331,000 yards, at 15 cents	1,099,650
Excavation below low-water, 41,184,000 yards, at 12½ cents	5,148,000
Dredging in Delaware Bay, 2,100,000 yards, at 10 cents	210,000
Protection walls Delaware Bay, 20,000 yards, at $3	60,000
Piling across Lewes Creek, 3,000 feet, at $7	21,000
Dredging (Queenstown), 2,000,000 yards, at 10 cents	200,000
Tide locks, 3, at $229,500	688,500
Railroad bridges, 3, at $90,000	270,000
Road bridges, 5, at $52,500	262,500
Land damages, 4,860 acres, at $50	243,000
Ten per cent. contingencies	3,387,385
Total cost	37,261,235

Centreville route:

Excavation above high-water, 146,800,000 yards, at 20 cents	$29,360,000
Excavation between high and low water, 7,500,000 yards, at 15 cents	1,125,000
Excavation below low-water, 36,000,000 yards, at 12½ cents	4,500,000
Dredging in Delaware Bay, 2,100,000 yards, at 10 cents	210,000
Dredging Chester River and Corsica Creek, 7,000,000 yards, at 10 cents	700,000
Dredging across Wilson's Point to 24 feet Chesapeake Bay, 2,840,000 yards, at 10 cents	284,000
Protection, &c., Delaware Bay, "as before"	60,000
Tide locks, 3, at $229,500	688,500
Railroad bridges, 4, at $90,000	360,000
Road brides, 5, at $52,500	262,500
Land damages, 4,600 acres, at $50	230,000
Ten per cent. contingencies	3,778,000
Total cost	41,558,000

Southeast Creek route:

Excavation above high-water, 85,000,000 yards, at 20 cents	$7,000,000
Excavation between high and low water, 4,600,000 yards, at 15 cents	690,000
Excavation below low-water, 23,200,000 yards, at 12½ cents	2,900,000
Dredging in Delaware Bay, 4,000,000 yards, at 10 cents	400,000
Dredging in Chester River and Southeast Creek, 3,500,000 yards, at 10 cents	350,000
Dredging to 24 feet in Chesapeake Bay, across Wilson's Point, 2,840,000 yards, at 10 cents	284,000
Protection walls Delaware Bay, 30,000 yards, at $3	90,000
Tide locks, 1, at $229,500	229,500
Railroad bridges, 3, at $90,000	270,000
Road bridges, 4, $52,500	210,000
Land damages, 2,900 acres, at $50	145,000
Ten per cent. contingencies	2,256,850
Total cost	24,825,350

Sassafras route:

Excavation above high-water, 18,300,000 yards, at 20 cents	$3,660,000
Excavation between high and low water, 1,887,000 yards, at 15 cents	283,050
Excavation below low-water, 13,586,000 yards, at 12½ cents	1,698,250
Dredging in Delaware Bay, 800,000 yards, at 10 cents	80,000
Dredging in Sassafras River above Georgetown, 3,500,000 yards, at 10 cents	350,000
Dredging in Sassafras and Chesapeake Bay, 5,500,000 yards, at 10 cents	550,000
Protection walls Delaware Bay, 30,000 yards, at $3	90,000
Tide locks, 1, at $229,500	229,500

Railroad bridges, 2, at $90,000	180,000
Road bridges, 3, at, $52,500	157,500
Land damages, 1,440 acres, at $50	72,000
Ten per cent. contingencies	735,030
Total cost	8,085,330

If the canal prism is reduced to 75 feet bottom and 153 feet low-water width, retaining same depth (26 feet) it will reduce cost of—

Ferry Creek route about	$1,500,000
Queenstown route about	4,000,000
Sassafras route about	800,000

If depth is reduced to 24 feet and low-water width to 147 feet, it will reduce the cost of—

Ferry Creek route about	$2,000,000
Queenstown route about	5,000,000
Sassafras route about	900,000

APPROXIMATE ESTIMATED COST OF A SHIP-CANAL, 15 FEET BELOW MEAN LOW-WATER, 100 FEET WIDE ON BOTTOM, WITH BERME (ONE SIDE) 19 FEET ABOVE BOTTOM.

Ferry Creek route:

Excavation above high-water, 30,433,000 yards, at 20 cents	$6,086,600
Excavation between high and low water, 5,000,000 yards, at 15 cents	750,000
Excavation below low-water, 14,840,000 yards, at 12½ cents	1,855,000
Dredging in Delaware Bay, 770,000 yards, at 10 cents	77,000
Dredging in Nanticoke, 2,800,000 yards, at 10 cents	280,000
Dredging in Choptank and Ferry Creek, 300,000 yards, at 10 cents	30,000
Protection walls, &c., as before	60,000
Railroad bridges, 3, at $90,000	270,000
Road bridges, 4, at $52,500	210,000
Tide locks, 3, at $140,000	420,000
Land damages, 3,500 acres, at $50	175,000
Ten per cent. contingencies	1,021,360
Total cost	11,234,960

Queenstown route:

Excavation above high-water, 111,000,000 yards, at 20 cents	$22,200,000
Excavation between high and low water, 5,900,000 yards, at 15 cents	885,000
Excavation below low-water, 22,500,000 yards, at 12½ cents	2,812,500
Dredging in Delaware Bay, 770,000 yards, at 10 cents	77,000
Dredging (Queenstown), 1,100,000 yards, at 10 cents	110,000
Tide locks, 3, at $140,000	420,000
Protection walls	60,000
Railroad bridges, 3, at $90,000	270,000
Road bridges, 5, at $52,500	262,500
Land damages, 4,860 acres, at $50	243,000
Ten per cent. contingenties	2,734,000
Total cost	30,974,000

Sassafras route:

Excavation above high-water, 16,206,000 yards, at 20 cents	$3,241,200
Excavation between high and low water, 1,400,000 yards, at 15 cents	210,000
Excavation below low-water, 6,550,000 yards, at 12½ cents	818,750
Dredging in Delaware Bay, 400,000 yards, at 10 cents	40,000
Dredging in Delaware Bay, 1,465,000 yards, at 10 cents	146,500
Dredging in Delaware Bay, 1,000,000 yards, at 10 cents	100,000
Protection walls, &c., as before	90,000
Tide locks, 1, at $140,000	140,000
Railroad bridges, 2, at $90,000	180,000
Road bridges, 3, at $52,500	157,500
Land damages, 1,400 acres, at $50	70,000
Ten per cent. contingencies	519,395
Total cost	5,713,345

As before indicated, the following changes in cost and distance by the Choptank route can be made by entering Chester River, cutting through Kent Island Narrows and the neck of land separating the Miles River from Third Haven (a wide and deep branch of the Choptank):

For canal 24 by 300 feet, from 24 feet water in Chester River to 24 feet water in Eastern Bay, 28,000 feet. Excavation, 4,000,000 yards, at 10 cents	$400,000
From 24 feet water in Miles River to 24 feet water in Third Haven, by way of Oak and Plaindealing Creeks, 34,000 feet. Excavation, 4,500,000 yards, costing	470,000
Making a total extra cost of	870,000

and a saving in distance over the route by mouth of Choptank equal to 10.9 miles.

SUMMARY.

The foregoing estimates show the following results as to cost and distance between extreme termini for the several routes:

Choptank	150	miles, cost	16½ million dollars.
Choptank (inland line)	139	miles, cost	18¼ million dollars.
Wye River	128½	miles, cost	26⅜ million dollars.
Queenstown	107¼	miles, cost	37¼ million dollars.
Centreville	106	miles, cost	41½ million dollars.
Southeast Creek	115¾	miles, cost	25 million dollars.
Sassafras	129¼	miles, cost	8 million dollars.

Assuming that steam-vessels can make 10 miles per hour in open water, 7 miles in dredged channels, and 5 miles per hour in the canal proper, the comparison as to time of transit and cost would be—

Choptank River	19½	hours,	16½ million dollars.
Choptank (inland)	18	hours,	18¼ million dollars.
Wye River	17⅜	hours,	26⅜ million dollars.
Queenstown	17	hours,	37¼ million dollars.
Centreville	16½	hours,	41½ million dollars.
Southeast Creek	15¾	hours,	25 million dollars.
Sassafras	15 1/10	hours,	8 million dollars.

A determination of the relative values of the respective routes also involves the question as to the facility and economy of maintenance of the dredged channels, as well as the ease and certainty of using the canal and its approaches in all seasons and at all times.

With regard to the maintenance of dredged channels, it may be said that on the Chesapeake side the Choptank and Wye River routes have all their approaches in the general directions of the tidal currents, and consequently they can be used with great facility and at a minimum of cost for maintenance.

The Sassafras, Queenstown, Centreville, and Southeast Creek lines have for several miles dredged approaches, which are necessarily transverse to the tidal and fluvial currents from the bay and the Susquehanna River, and from the experience in the ship-channels now leading to Baltimore, it may be confidently predicted that the maintenance of their channels of approach will require a large annual outlay.

On the Delaware side, the Sassafras, Choptank, Queenstown, and Centreville lines have about equal facilities for economic maintenance; but the Wye and Southeast Creek lines, requiring several miles of channel through the shoals, at right-angles to the direction of winds and tides, would prove so difficult to maintain or to enter during a storm that they may be pronounced almost impracticable. The continued use of the canal during the winter season is also of vital importance, and is dependent on the relative temperatures as well as on the configuration of the adjacent shores, &c.

Appended to this report will be found a tabular statement showing the number of days from 1851 to 1878, during which navigation was suspended on account of ice, at three points on the Chesapeake which cover the country to be traversed by the Sassafras.

QUEENSTOWN AND CHOPTANK ROUTES ON THE CHESAPEAKE SIDE.

No records were obtainable for the Delaware side, but it may be generally stated as a known fact that Delaware Bay is more frequently obstructed by ice than the Chesapeake, and that owing to the greater tidal range, it moves more rapidly and violently than on the Chesapeake, and is consequently more obstructive to navigation.

The records referred to show that the navigation of the Chesapeake and Delaware Canal has been closed by ice for an average of about 23½ days per annum in twenty-

one years; that of Chester River for 24 days per annum in the same time, and of the Choptank about 10½ days, or less than one-half the average time of closure of the other two, which are practically on an equality in this respect.

During this same period, twenty-one years, the Choptank has been open or unobstructed by ice for ten years, or nearly one-half the whole time. While the canal and Chester River have been so obstructed during only about one-fourth of the period, showing clearly, and notwithstanding possible inaccuracies in reports, that the region covered by the Choptank route possesses marked advantages in this respect over any of those passing through the Chester or Sassafras Rivers.

In addition to these records, I may say, as having had personal experience in the matter, that on the Chesapeake side during such winters as that of 1876–'77, the ice from the upper bay and the Susquehanna River, broken from the shore in large masses (measured by square miles), is driven by the tides and winds into the mouth of the Sassafras and Chester Rivers, where it is piled cake upon cake until its forms an obstruction truly formidable to be encountered even by the most powerful iceboats.

SUMMARY OF ROUTES.

A review of the preceding figures and remarks would indicate that the Sassafras route is the shorter in time and the cheaper route, but has very expensive approaches to maintain and very serious conditions to be overcome if it is to be used during the winter.

The Centreville and Queenstown routes are the more direct to the objective point, rate second as to time, but cost largely in excess of other routes; have expensive approaches to maintain on the Chesapeake side and are, as the Sassafras route, liable to obstruction by ice during the winter.

The Choptank route rates slightly below the Sassafras as to time of transit, and rates third in this respect, while it is second on the list in point of cost; its greatest advantages being in the matters of freedom from obstruction by ice and economy of maintenance of approaches.

The distances usually traversed by coasting vessels (and the comparison would not vary essentially for transatlantic voyages) going from Baltimore northward by way of the capes, and passing 12 miles outside the Delaware Breakwater, is about 325 miles, or say for steamers 33¼ hours; under which assumption the savings in time and distance by the several land routes would be as follows:

	Hours.	Miles.
Choptank	13¾	175
Choptank (inland)	15	186
Wye River	15½	196½
Queenstown	16¼	217¾
Centreville	16¾	219
Southeast Creek	17½	209¼
Sassafras	18 1/10	195¾

It may be remarked in this connection that a point at sea 10 miles beyond the Delaware Breakwater is reached by the Choptank (two routes) in a distance 10 and 21 miles, respectively, less than that required to reach Cape Henry (mouth of Chesapeake), Baltimore being the starting point. This saving of distance between those two points (one off Delaware Bay and the other at mouth of Chesapeake) is increased on the Sassafras line to 40 miles, and on the Queenstown to nearly 63 miles. These relations become important in view of the fact that most if not all the large sailing-vessels carrying grain between Baltimore and Europe are towed by tugboats to and from the capes.

And it is also important to observe that when vessels are in tow of tugs, the time of transit through canal proper will be at an equal rate per hour with the speed made in open water, and probably greater, as opposing winds will not exercise so great power, and the large size of canal prism will render the resistance to movement in the canal no greater than that in open water.

Under these circumstances, the economy in time would be at the lowest estimate proportional to the economy in distance, and not less than from 22 to 24 hours in any route.

In conclusion, I would say that I was zealously assisted by Mr. W. H. Smith, as principal assistant, and also in immediate charge of borings, and Messrs. W. Goldborough, I. L. Thorp, in charge of parties.

Appended will be found "records of tides observed," and of "times of closure of navigation by ice."

Owing to the flatness of the surface of the whole peninsula within limited distances on either sides of any line surveyed, there is an entire absence of any topographical features with which to fill up the maps. For this reason the general map submitted shows much blank space, as the lines traversed miles of country with hardly a change of surface perceptible to the eye; and for the same reasons no large scale plots are sub-

mitted of any whole lines (except some rough ones made in the field), all such drawings being confined to special localities where the country possessed special characteristics.

It was intended that the general map (5,000 feet to 1 inch) in connection with the profiles or even without, as the elevations are marked on all the lines on the map, should enable the general results to be obtained without the trouble of examining large detailed sheets which really give no more information than can be obtained from the smaller ones, which have the advantage, moreover, of permitting at one time a review of all the routes surveyed and their relations to the two bays and to each other.

The following note-books, maps, and drawing are submitted herewith:

2 sheets, map of peninsula and routes surveyed, $\frac{1}{60000}$.
2 sheets, profiles of three principle routes.
1 sheet, plan of locks, bridges, and canal prism.
2 sheets, diagram of tidal movements.
2 sheets, sections of borings.
3 sheets, Choptank route, Walnut Landing to Broadkill, 1″ to 800′.
1 sheet, Broadkill Creek, 1″ to 800′.
1 sheet, Terry Creek, 1″ to 800′.
1 sheet, Broadkill and Mispillion Creeks, 1″ to 800′.
1 sheet Queenstown route, 1″ to 400′.
1 sheet Corsica Creek (Centreville line), 1″ to 800′.
2 sheets, Wye River route, 1″ to 400′.
1 sheet, Secretary Creek (Choptank line), 1″ to 800′.
1 sheet, Secretary Creek route (Choptank line), 1″ to 400′.
1 sheet, line from Maxmire Creek by way of Plaindealing and Peachblossom to Choptank River, 1″ to 400′.
1 sheet (tracing), of Sassafras route (Tebbets).
2 sheets (tracing), hydrography of Nanticoke, 1″ to 400′.
1 sheet (tracing), hydrography of Chester River, Queenstown, Corsica, and Southeast Creek, United States Coast Survey, $\frac{1}{20000}$.
1 sheet (tracing), hydrography of Choptank River, third Peachblossom and Plaindealing Creeks, United States Coast Survey, $\frac{1}{20000}$.
1 sheet (tracing), hydrography of Eastern Bay, Wye River, and Skipton Creek, United States Coast Survey, $\frac{1}{20000}$.
1 sheet (tracing), hydrography of Breakwater Harbor (Colonel Macomb), 1″ to 300′.
1 sheet (tracing), Mispillion Creek (Colonel Macomb), 1″ to 600′.
1 sheet (tracing), profile Sassafras route (Tebbets).
4 sheets, profile of Southeast Creek route.
3 sheets, profile of Indian Creek route.
1 sheet, profile of Wye River route.
1 sheet, profile of Secretary Creek route.
4 sheets, profile of Queenstown route.
1 sheet, profile of Centreville route.
4 sheets, profile of line from Miles River by way of Plaindealing and Peachblossom Creek to Choptank. 39 sheets, cross-sections of Ferry Creek, Nanticoke River, and Broadkill.
2 transit-books, Queenstown line.
2 level-books, Queenstown line.
1 transit-book, Indian and Ferry Creek lines.
1 level-book, Indian and Ferry Creek lines.
4 transit-books, Secretary Creek line.
3 level-books, Secretary Creek line.
4 hydrographic books of Nanticoke, Indian, and Ferry Creek surveys.
2 transit-books, survey of Oak, Maxmire, Plaindealing, and Peachblossom Creeks.
1 level-book of same survey.
2 transit-books, Wye River line.
1 level-book, Wye River line.
1 transit-book, Southeast Creek line.
2 level-books, Southeast Creek line.
1 transit-book, Centreville line.
2 level-books, Centreville line.
2 transit-books, Broadkill.
3 general note-books.
6 books, tent-levels.
8 books, tide-records.

Respectfully submitted.

N. H. HUTTON,
Assistant in Charge of Surveys.

Col. W. P. CRAIGHILL,
Major of Engineers, U. S. A.

Tidal observations at Secretary Creek, Maryland.

[NOTE.—N. E. L., northeast wind light; S. W. H., southwest wind heavy, &c.]

Date.	Time.	H. W.	L. W.	Remarks.
	9.30 a. m.			
Sept. 4	4 p. m.	1.9	0.15	
	10.30 a. m.			
5	6.40 p. m.	2.25	0.2	
	12 m.			
6	6.40 p. m.	1.85	0.2	
	2 p. m.			
7	7.30 p. m.	2.1	0.5	
	9 a. m.			
8	2 p. m.	2.7	1.2	
	2 p. m.			
9	7 p. m.	3.1	1.5	L. N. E.
	4.20 p. m.			
10	10 a. m.	2.6	0.95	N. E. L.
	5 p. m.			
11	11 a. m.	2.9	0.7	N. E. L.
	4.50 p. m.			
12	11 a. m.	3.25	1.8	N. E. L.
	3.30 p. m.			
13	5.30 a. m.	5.04	3.8	S. E. H.
	6.15 p. m.			
14	11 a. m.	2.0	0.15	
15	1.45 p. m.		—0.15	Very low all day.
	6 p. m.			
16	1 p. m.	2.1	0.15	
	7.30 a. m.			
17	1.40 p. m.	2.4	0.8	
	8.15 a. m.			
18	2.30 p. m.	2.4	0.5	
	9.15 a. m.			
19	3.30 p. m.	1.55	—0.1	
	9.20 a. m.			
20	4.15 p. m.	2.45	0.8	
	10.20 a. m.			
21	5 p. m.	2.35	0.45	
	11.40 a. m.			
23	7.30 a. m.	2.25	0.6	
	2.45 p. m.			
24	9 a. m.	2.8	1.0	
	3 p. m.			
25	9 a. m.	2.5	0.6	
	3 p. m.			
26	9.45 a. m.	2.1	0.8	
	4.40 p. m.			
27	11 a. m.	1.95	0.65	
	5 p. m.			
28	11.25 a. m.	2.65	0.4	
	5.40 p. m.			
29	12.25 p. m.	2.85	0.8	
	6 a. m.			
30	1 p. m.	2.4	0.2	
	6.30 a. m.			
Oct. 1	1.35 p. m.	2.4	0.45	
	8 a. m.			
2	2.45 p. m.	2.4	0.5	
	9 a. m.			
3	3.30 p. m.	2.1	0.15	
	9.50 a. m.			
4	3.55 p. m.	1.7	0.3	
	10.30 a. m.			
5	5.30 p. m.	1.7	0.3	
	1.30 p. m.			
7	7.30 a. m.	2.25	0.4	
	2.20 p. m.			
8	8.30 a. m.	2.45	0.7	
	3.15 p. m.			
9	9.30 a. m.	2.6	0.75	S. H.
	4 p. m.			
10	10 a. m.	1.55	—0.2	
	4.15 p. m.			
Oct. 11	10.25 a. m.	1.85	0.0	
	5 p. m.			
12	11 a. m.	2.1	0.05	
	5.25 p. m.			
14	12.30 p. m.	2.7	0.5	
	6.10 a. m.			
15	12.45 p. m.	2.65	1.0	
	7 a. m.			
16	1.15 p. m.	1.95	0.25	
	7.30 a. m.			
17	1.30 p. m.	1.8	0.3	
	7.50 a. m.			
18	2.15 p. m.	2.0	0.4	
	9.25 a. m.			
19	3 p. m.	1.6	0.45	W. H.
	12.30 p. m.			
21	5.45 p. m.	1.3	—0.35	
	12 m.			
22	6.30 a. m.	1.5	—0.3	
	12 m.			Tide above gauge.
23	6.30 a. m.			E. H.
	1.15 p. m.			
24	9.10 a. m.	2.0	0.25	
	3.20 p. m.			
25	9.30 a. m.	2.3	—0.1	
	3.30 p. m.			
26	10 a. m.	3.15	0.8	
	5 p. m.			
28	11.40 a. m.	2.2	0.1	
	5 p. m.			
29	12.30 a. m.	2.2	0.3	
	6.30 p. m.			
30	1 p. m.	2.8	1.1	S. E. L.
	8 a. m.			
31	2.30 p. m.	2.85	1.15	N. W. brisk.
	8 a. m.			
Nov. 1	3 p. m.	0.9	—0.4	N. W. H.
	8 a. m.			
2	5 p. m.	2.1	0.4	
	11.30 a. m.			
4	4.30 p. m.	1.9	0.7	
	1 p. m.			
5	7 a. m.	1.7	0.05	
	1.30 p. m.			
6	8 a. m.	2.1	0.6	
	2.30 p. m.			
7	9 a. m.	1.4	—0.4	
	1.30 p. m.			
8	7.30 a. m.	2.2	0.85	
	4 p. m.			
9	8.30 a. m.	1.7	0.35	Strong N. W.
	4.30 p. m.			
11	11 a. m.	2.0	0.05	
	5 p. m.			
12	12.30 p. m.	2.35	0.5	
	5.30 p. m.			
13	11.30 a. m.	2.5	0.45	W. H.
	5 p. m.			
14	1 p. m.	1.15	—0.4	N. W. L.
	7 a. m.			
15	1.30 p. m.	1.05	—0.4	
	8 a. m.			
16	2.30 p. m.	1.4	0.5	
	10 a. m.			
18	4 p. m.	1.9	0.0	N. stiff.
	11 a. m.			
19	5 p. m.	2.25	0.65	
	1 p. m.			
20	7 a. m.	2.7	0.8	

Mean high water, 2.08 feet; mean low water, 0.26 foot; mean range of tide, 1.82 feet.

Observation at Lewes, Del.

Date.	Time.	H. W.	L. W.	Remarks.	Date.	Time.	H. W.	L. W.	Remarks.
	8 a. m.				Oct. 31	.....	4.7		
Oct. 11	2 p. m.	4.2	0.2			1.30 p. m.			
	9 a. m.				Nov. 1	.....	3.6		
12	3 p. m.	5.9	1.4			3 p. m.			
	10 a. m.				2	8 a. m.	3.0	—0.6	
14	4 p. m.	4.7	0.2			4 p. m.			
	10.30 a. m.				4	10 a. m.	3.3	—0.0	
15	4.30 p. m.	4.2	—0.1		5	11 a. m.	.....	—0.4	
	11 a. m.				6	11.30 a. m.	.....	—0.6	
16	.....	3.6			7	12.30 p. m.	.....	—0.2	
	12 m.					7 a. m.			
17	.....	3.6			8	1 p. m.	3.2	—0.9	
	1 p. m.					8 a. m.			
18	.....	4.2			9	2 p. m.	3.6	—1.1	
19	7 a. m.	.....	—0.2			9 a. m.			
	4 p. m.				11	3 p. m.	4.7	0.0	
21	9.30 a. m.	3.2	—1.2			9.30 a. m.			
	5 p. m.				12	3.30 p. m.	4.3	—0.2	
22	10.30 a. m.	4.3	—0.7			10 a. m.			
24	12.30	.....	—1.2		13	4.30 p. m.	4.1	—0.9	
	7.30 a. m.					10.30 a. m.			
25	2 p. m.	5.4	—0.3		14	5 p. m.	3.5	—0.8	
	8 a. m.					11 a. m.			
26	2.30 p. m.	5.6	—1.0		15	5.30	3.5	—0.4	
	10 a. m.					12 m.			
28	4 p. m.	4.9	—0.5		16	6 a. m.	3.7	—0.1	
	11 a. m.					3 p. m.			
29	5 p. m.	4.9	—0.2		18	8 a. m.	4.0	—0.5	
	11.30 a. m.					4 p. m.			
30	.....	5.3			19	9 a. m.	3.9	—0.2	
	12.30 p. m.				26	.....	.....	.....	

Low water established; mean range of tide, 4.35 feet.

Tidal observations at Walnut Landing, Nawticoke River, Maryland.

Date.	Time.	H. W.	L. W.	Remarks.
	1.15 p. m.			
Sept. 7	8.30 a. m.	3.15	0.2	
	2 p. m.			
8	9.30 a. m.	3.25	0.7	
	4.30 p. m.			
9	10.45 p. m.	3.5	1.25	
	3.45 p. m.			
10	11.15 p. m.	3.4	0.75	
	4.20 p. m.			
11	11.15 p. m.	3.5	0.8	
	5.45 p. m.			
12	11.15 p. m.	3.7	1.25	E. to S. E. H.
	5 p. m.			
13	.....	4.85	.....	S. E. H.
	6 a. m.			
14	12 m.	3.05	0.15	
	6.35 a. m.			
15	1.10 p. m.	2.6	—0.4	
	7.15 p. m.			
16	1.35 a. m.	3.0	—0.4	
	7.30 p. m.			
17	2.15 p. m.	3.2	0.6	
	8.30 p. m.			
18	3 p. m.	3.1	0.7	
	9 p. m.			
19	3 p. m.	2.9	0.0	
	10.30 a. m.			
20	5.15 p. m.	3.1	0.2	
	11.30 a. m.			
21	5.45 p. m.	2.9	0.2	
	12.30 p. m.			
22	7.15 a. m.	1.6	0.75	
	1.15 p. m.			
23	7.30 a. m.	3.0	0.1	
	2.45 p. m.			
24	8.30 a. m.	3.4	0.6	
	4.00 p. m.			
25	9.30 a. m.	3.35	0.45	
	4.30 p. m.			
26	10 a. m.	3.5	0.65	
	5.30 p. m.			
27	11 a. m.	3.15	—1.2	
	6.00 p. m.			
28	12.30 p. m.	3.4	—0.6	
	6.00 p. m.			
29	1 p. m.	3.5	0.35	
	6.00 p. m.			
30	2 p. m.	3.5	0.0	
	8 a. m.			
Oct. 1	2 p. m.	3.5	0.45	
	9.30 a. m.			
2	4 p. m.	3.1	0.45	
	10 a. m.			
3	5 p. m.	2.85	0.0	
	10.30 a. m.			
4	5 p. m.	2.5	0.0	
	12.30 p. m.			
5	6.40 a. m.	2.4	0.0	
	1 p m.			
6	7 a. m.	2.85	0.15	
	3 p. m.			
7	8.30 a. m.	3.0	0.15	
	2.15 p. m.			
8	9 a. m.	3.0	0.5	
	4 p. m.			
9	9.30 a. m.	3.35	0.85	S. H.
	4 p. m.			
10	11 a. m.	2.3	—0.55	N. L.
	3 p. m.			
11	10 a. m.	2.65	—0.6	N. L.
	5 p. m.			
12	11.30 a. m.	2.7	—0.25	N. L. to H.
	6.30 p. m.			
13	12 m.	3.45	0.4	
	6 p. m.			
14	12 m.	3.3	0.6	
	7 p. m.			
15	1 p. m.	3.5	1.0	S. stiff.
	7.15 a. m.			
	8 a. m.			
16	1.30 p. m.	2.7	0.35	
17	2 p. m.	2.7	0.6	
	9 a. m.			
18	3 p. m.	2.7	0.25	
	9.45 a. m.			
19	4 p. m.	2.3	—0.1	
	11 a. m.			
20	4.30 p. m.	1.8	—0.4	
	12 m.			
21	6.30 a. m.	2.3	—0.5	
	1 p. m.			
22	7 a. m.	2.45	—0.8	
	1 p. m.			S. E. gale.
23	6 a. m.	4.9	0.5	
	2 p. m.			
24	10 a. m.	2.8	0.5	
	4 p. m.			
25	10 a. m.	3.15	—0.7	
	4 p. m.			
26	10.30 a. m.	3.7	0.4	
	5.30 p. m.			
27	11 a. m.	3.8	0.8	
	6.15 p. m.			
28	1 p. m.	3.2	—0.2	
	6 a. m.			
29	1 p. m.	3.5	0.0	
	7 a. m.			S. E. stiff.
30	2 p. m.	3.3	1.05	
	8.30 a. m.			Stiff N. W.
31	3.20 p. m.	3.3	—1.7	
	9 a. m.			
Nov. 1	3 p. m.	1.15	—0.25	
	10.20 a. m.			
2	5 p. m.	3.0	0.55	
	10 a. m.			
3	5 p. m.	1.45	0.75	
	11 a. m.			
4	7 a. m.	2.6	0.7	
	2 p. m.			
5	8 a. m.	2.5	—0.4	
	2.15 p. m.			
6	8 a. m.	3.0	0.6	
	3 p. m.			
7	9 a. m.	2.35	—0.35	N. W. H.
8	9 a. m.	.....	0.4	
	4 p. m.			
9	9.45 a. m.	2.5	—0.65	
	4 p. m.			
10	10.30 a. m.	2.4	—0.6	
	5 p. m.			
11	10 a. m.	3.0	—0.1	
	5.45 p. m.			
12	12 m.	3.5	—0.4	
	5 p. m.			
13	12 m.	2.9	0.6	
	5 p. m.			
14	1 p. m.	2.0	—0.7	
	7.45 a. m.			
15	1.45 p. m.	1.9	—0.6	
	9 a. m.			
16	2.30 p. m.	2.5	—0.25	
	9.30 a. m.			
17	3.30 p. m.	2.65	0.2	
	10.30 a. m.			
18	4 p. m.	2.8	0.25	
	11.30 a. m.			
19	5 p. m.	3.0	0.65	
	1 p. m.			
20	7 a. m.	3.3	0.6	
	2 p. m.			S. E. H.
21	7 a. m.	3.6	1.3	
	5 p. m.			
22	8 a. m.	4.1	0.75	
	3 p. m.			N. W. H.
23	10.30 a. m.	3.15	1.4	
	4.30 p. m.			
24	10.30 a. m.	3.2	—0.6	
	5 p. m.			
25	11 a. m.	3.0	—0.45	

Mean high water, 2.83 feet; mean low water, 0.0821 feet; mean range of tide, 2.75 feet.

Observations at Georgetown, Sassafras River, Maryland.

Date.	Time.	H. W.	L. W.	Remarks.	Date.	Time.	H. W.	L. W.	Remarks.
	12 m.					6.45 p. m.			
Nov. 13	5 p. m.	2.0	0.5		Nov. 22	12 m.	4.87	1.08	S. W. H.
	12.15 a. m.					6 p. m.			
14	6 a. m.	0.33	0.74	N. W. H.	23	10 a. m.	2.83	1.58	N. W. H.
	1 p. m.					9.30 a. m.			
15	6 a. m.	1.41	0.08		25	3 p. m.	1.91	0.16	
	1.30 p. m.					9.45 a. m.			
16	7 a. m.	1.74	0.16		26	3.45 a. m.	1.83	0.08	
	3.30 p. m.					10.45 a. m.			
18	9.30 a. m.	1.25	0.41		27	6 a. m.	2.16	0.66	
	4 p. m.					10 a. m.			
19	10 a. m.	3.0	0.83		28	6 p. m.	3.33	1.08	N. W. H.
	5 p. m.					1 p. m.			
20	10.30 a. m.	3.58	0.83	N. E. L.	29	6 p. m.	2.0	0.5	
	6 p. m.					2 p. m.			
21	12 m.	3.91	1.5	S. E. H.	30	8 a. m.	1.66	0.16	

Mean high water, 2.00 feet; mean low water, 0.3 feet; mean range of tide, 1.7 feet.

Observations at Seaford, Del.

Date.	Time.	H. W.	L. W.	Remarks.	Date.	Time.	H. W.	L. W.	Remarks.
	7 a. m.				Oct. 15	2 p. m.	3.9	1.2	
Sept. 16	1 p. m.	3.5	0.0			8 a. m.			
	8 a. m.				16	2 p. m.	3.5	0.3	
17	2 p. m.	3.65	0.85			9 a. m.			
	9 a. m.				17	3 p. m.	3.5	0.9	
18	3 p. m.	3.8	1.0			9 a. m.			
	10 a. m.				18	5 p. m.	3.55	0.4	
19	4 p. m.	3.175	0.35			12 m.			
	11 a. m.				19	5 p. m.	3.5	0.25	
20	5 p. m.	3.8	1.4			12 m.			
	12 m.				20	5 p. m.	2.8	—0.2	N. W. H.
21	5 p. m.	3.6	0.5			1 p. m.			
	1 p. m.				21	7 a. m.	3.2	—0.3	S. W. L. to H.
22	7 a. m.	2.3	—0.4	N. E. H.		1 p. m.			
	2 p. m.				22	7 a. m.	3.9	0.1	
23	8 a. m.	3.65	0.225						
	3 p. m.				23	7 a. m.	.....	1.9	S. E. gale.
24	9 a. m.	4.1	0.8			11 a. m.			
	4 p. m.				24	6 p. m.	4.15	0.9	
25	10 a. m.	4.1	0.85			1 p. m.			
	5 p. m.				25	7 a. m.	3.3	0.1	
26	11 a. m.	4.3	0.9			2 p. m.			
	6 p. m.				26	8 a. m.	2.6	0.1	
27	11 a. m.	3.8	—0.9	N. E. H.		1 p. m.			
	6 p. m.				27	9 a. m.	2.6	0.5	
28	12 m.	4.0	—0.1	N. E. H.		4 p. m.			
	7.15 a. m.				28	10 a. m.	3.15	0.9	
29	1 p. m.	3.9	0.6			7 a. m.			
	8 a. m.				Oct. 29	1 p. m.	2.85	0.05	
30	2 p. m.	3.9	0.2			1 p. m.			
	9 a. m.				30	6 p. m.	3.65	1.4	
Oct. 1	3 p. m.	3.8	1.0			6 p. m.			
	10 a. m.				31	11 a. m.	2.85	—0.3	N. W. H.
3	5 p. m.	3.65	0.3			10 a m.			
	11 a. m.				Nov. 1	6 p. m.	3.85	0.8	N. W. L. to H.
4	6 p. m.	3.2	0.2			6 p. m.			
	1 p. m.				2	9 a. m.	3.8	—0.15	N. W. L.
5	7 a. m.	2.9	0.5	N. E. H.		8 a. m.			
	2 p. m.				3	6 p. m.	3.8	—0.45	
6	8 a. m.	3.8	1.3	N. E. H.		3 p. m.			
	3 p. m.				4	8 a. m.	3.2	—0.2	
7	9 a. m.	3.8	0.3			2 p. m.			
	4 p. m.				Nov. 15	8 a. m.	4.0	—1.7	
Oct. 8	10 a. m.	3.85	1.7			4 p. m.			
	5 p. m.				16	8.30 a. m.	4.05	1.6	
9	10 a. m.	4.275	1.3	S. W. H.		7.30 a. m.			
	5 p. m.				17	1 p. m.	3.8	1.0	
10	11 a. m.	3.4	0.05			9 a. m.			
	4 p. m.				18	2.30	3.85	0.7	
11	12 a. m.	3.4	—0.3	N. E. W.		7.30 a. m.			
	6 p. m				20	2 p. m.	4.1	0.5	
12	12 m.	3.5	—0.1	N. E. H.		9 a. m.			
	5 p. m.				21	3.15 p. m.	3.2	0.15	
13	1 p. m.	3.7	0.4			11.30 a. m.			
	7 a. m.				23	4.15 p. m.	2.775	0.45	N. W. H.
14	1 p. m.	3.9	0.8						
	7 a. m.								

Mean high water, 3.42 feet; mean low water, 0.35 feet; mean range of tide, 3.07 feet.

Observations at Queenstown, Md.

Date.	Time.	H. W.	L. W.	Remarks.	Date.	Time.	H. W.	L. W.	Remarks.
	7.30 a. m.					3 p. m.			
Oct. 30	3.30 p. m.	2.58	1.25	W. W. H.	Nov. 8	10 a. m.	1.41	0.83	
	11 a. m.					5.30 p. m.			
31	4.30 p. m.	2.5	1.0	W. W. H.	9	12 m.	1.33	—0.33	
	6 a. m.					6 p. m.			
Nov. 1	5 p. m.	0.74	—0.49	N. W. H.	11	12 m.	1.83	0.0	
	12 m.					7.30 a. m.			
2	6 p. m.	1.66	0.66		12	1.30 p. m.	1.83	0.58	
	3 p. m.					6 p. m.			
4	7 a. m.	1.49	0.58		13	1 p. m.	1.74	0.74	
	3 p. m.					6 p. m.			
5	10 a. m.	1.25	0.08	N. W. L.	14	2 p. m.	0.66	—0.49	N. L.
	4 p. m.					8.30 a. m.			
6	10.30 a. m.	1.74	0.75		15	2.30 p. m.	0.49	—0.25	N. L.
	6 p. m.					10 a. m.			
7	9.30 a. m.	1.25	—0.41	E. L.	16	4.30 p. m.	1.0	0.08	

Mean high water, 1.37 feet; mean low water, 0.08 feet; mean range of tide, 1 29 feet.

Observations at Little Creek Landing, Delaware.

Date.	Time.	H. W.	L. W.	Remarks.	Date.	Time.	H. W.	L. W.	Remarks.
	1 p. m.					5 p. m.			
Dec. 14	7.15 a. m.	5.41	0.0		Dec. 18	11 a. m.	5.91	—0.12	L. N. W.
	2 p. m.					7 a. m.			
15	8 a. m.	5.74	0.74		19	1 p. m.	3.5	—1.0	L. N. W.
	2 p. m.					7 a. m.			
16	10 a m.	4.91	0.74		20	2 p. m.	4.83	—0.5	L. N. W.
	4 p. m.					8 a. m.			
17	10 a. m.	4.91	0.58		21	3 p. m.	5.33	1.74	S. mod.

Mean high water, 5.29 feet; mean low water, 0.31 feet; mean range of tide, 4.98.

Observations at Blackbird Creek, New Castle, Del.

Date.	Time.	H. W.	L. W.	Remarks.	Date.	Time.	H. W.	L. W.	Remarks.
	2.15 p. m.				Nov. 22	7 a. m.	4.5	3.2	E. H.
Nov. 13	8 a. m.	3.4	0.0	N. W. H.		11 a. m.			
	4.15 p. m.				23	6 p. m.	4.05	1.55	N. W. H.
14	9.30 a. m.	3.5	—0.35	N. W. H.		1.15 p. m.			
	4.45 p. m.				24	7.30 a. m.	3.625	0.25	S. W. H.
15	10.15 a. m.	3.55	—0.05			2.45 p. m.			
	5 p. m.				25	6.30 a. m.	4.0	0.35	
16	11.15 a. m.	3.575	0.8			3.30 p. m.			
	7 a. m.				26	9.15 a. m.	3.775	0.8	
17	1.30 p. m.	3.5	0.025			3 p. m.			
	7.30 a. m.				27	10.30 a. m.	4.6	1.4	
18	2 p. m.	3.725	1.8			7 a. m.			
	8.30 a. m.				28	11.15 a. m.	4.0	1.75	N. W. H.
19	3 p. m.	3.775	1.7	E. H.		6 p. m.			
	10.30 a. m.				29	11 a. m.	3.7	—0.4	W. H.
20	6 p. m.	3.95	2.2	S. E. H.		5 p. m.			
	12 m.				30	12 m.	3.35	—0.125	
21	6.30 p.m.	4.925	2.6	E. H.		7 a. m.			
	2.30 p.m.				Dec. 1	12.30 p. m.	3.5	0.5	

Mean high water, 3.60 feet; mean low water, 0.17 feet; mean range of tide, 3.43 feet.

Observations at Milford, Del.

Date.	Time.	H. W.	L. W.	Remarks.	Date.	Time.	H. W.	L. W.	Remarks.
	8 a. m.				Oct. 27	5 p. m.	3.0	1.8	
Oct. 22	3 p. m.	1.25	—1.2	S. E. H.		2 p. m.			
	7 a. m.				28	8 a. m.	2.7	0.3	
23	11.45 a. m.	3.2	2.0	S. E. gale.		2 p. m.			
	9 a. m.				29	7 a. m.	2.8	0.0	
24	6 p. m.	3.0	1.25			2 p. m.			
	12 m.				30	9 a. m.	2.95	0.5	
25	7 a. m.	3.2	1.3			3 p. m.			
	1 p. m.				31	10 a. m.	2.7	0.7	
26	7 a. m.	3.0	1.1			5 p. m.			
	12 m.				Nov. 1	8 a. m.	2.4	0.15	

Mean high water, 2.59 feet; mean low water, 0.27 feet; mean range of tide, 2.32 feet.

Location of gauge.	High tide.	Low tide.	Range.
Walnut Landing	2.83	0.082	2.75
Blackbird Creek	3.60	0.17	3.43
Georgetown, Sassafras River	2.00	0.30	1.70
Secretary Creek	2.08	0.26	1.82
Queenstown Creek	1.37	0.08	1.29
Little Creek Landing	5.29	0.31	4.98
Miford	2.59	0.27	2.32
Seaford	3.42	0.35	3.07
Lewes			4.35

Record of duration of closure of navigation on account of ice

Years.	Chesapeake and Delaware Canal, from Delaware City to Chesapeake City, Elk River.	Kent Island, Chester River, near its mouth.	Island Creek (Choptank River, near its mouth.	Remarks.
	No. of days.	*No. of days.*	*No. of days.*	
1855	19	0	0	The records as to Chesapeake and Delaware Canal are from Mr. E. Shriver, general manager of Philadelphia and Baltimore Steamboat Company, and indicate the times during which their propeller freight steamers, even when "doubled," could not force a passage through the ice. The records for Chester River are from the late Col. R. Tilghman, and those for Choptank from Mr. R. Willis, and both relate to passage of light side-wheel passenger boats.
1856	81	69	48	
1857	47	36	28	
1858	24	8	9	
1858	3	2	0	
1860	14	12	0	
1861	0	0	0	
1862	0	0	0	
1863	0	0	0	
1864	23	34	5	
1865	50	38	20	
1866	28	37	0?	
1867	46	83	5	
1868	62	26	0	
1869	5	Not given.	0	
1870	6	0	6	
1871	31	55	25	
1872	24	84?	0?	
1873	35	20	5	
1874	0	0	0	
1875	41	44	0	
1876	15	59?	20	
1877	36	43	51?	
1878	0	18	0	
24				
	590	668	222	

Excluding from the above the records for 1866, 1872, and 1875, where the discrepancy is so great as to warrant the belief of error in the record, we have for twenty-one years the following total duration of closure from ice.

On canal 497 days, or say 23½ days per annum.

On Chester River 503 days, or say 24 days per annum.

On Choptank River 221 days, or say 10½ days per annum.

It must, however, be borne in mind that the records for the Chesapeake and Delaware Canal refer to the forced passage of powerful steamers, which always run when possible, and never stop for five or six inches of ice.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., March 30, 1872.

SIR: In reply to the resolution of the House of Representatives of March 11, 1872, requesting information upon the subject of the construction of a ship-canal from the waters of the Chesapeake to the waters of Delaware Bay, I herewith transmit a copy of remarks made by the Hon. James T. Earle, of Maryland, upon the occasion of a visit to this office of a joint committee of the legislature of Maryland and of Governor Ponder, of Delaware, with the view of obtaining the services of an officer of the Corps of Engineers to make the surveys necessary to determine the feasibility of such a work. These remarks were written out at my request, as they contained many facts of interest relating to the commence of Baltimore. I also send a copy of a communication from Major Craighill, Corps of Engineers, to whom this resolution was referred for report thereon, with a letter inclosed from Mr. A. Harris, the agent in Baltimore of several lines of steamships. These papers contain all the information in my possession bearing upon the project in question.

Major Craighill believes that the length of line of such a canal would probably not be less than 30 miles, nor exceed 55 miles, depending upon the location, but no reliable estimate of the cost of its construction can be given without careful preliminary surveys. The character of the country through which it would pass is favorable for such a work.

A canal connecting the two bays, as proposed, would shorten the distance from Baltimore to many European ports as well as to those on our own coast north of Baltimore. Mr. Earle estimates this distance at 182 miles each way, or 364 miles each trip, which is no doubt approximately accurate. This question, and the other question of the resolution, whether the building of such a canal would not materially advance the interests of commerce, are treated at some length in these communications, and the advantages to follow the shortening of the route to sea are ably presented.

The next step in the discussion is to ascertain the degree of feasibility and the cost of that shortening; and this being accomplished, the final conclusion as to economy of time and money can be determined. Upon that conclusion rests the decision whether the route should be opened.

The cost of the necessary surveys and preparation of plans Major Craighill estimates at $20,000, which sum is recommended to be appropriated.

The resolution of the House of Representatives is herewith returned.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier-General and Chief of Engineers.

Hon. W. W. BELKNAP,
Secretary of War.

REMARKS SUBMITTED TO GENERAL HUMPHREYS, OF THE WAR DEPARTMENT, ON THE 29TH OF FEBRUARY, BY THE HON. JAMES T. EARLE, OF THE JOINT COMMITTEE OF THE LEGISLATURE OF MARYLAND, ON BEHALF OF THE STATE AND OF GOVERNOR PONDER, OF DELAWARE, ON THE SUBJECT OF A SHIP-CANAL TO CONNECT THE WATERS OF THE CHESAPEAKE AND DELAWARE BAYS, WITH A VIEW TO PROCURE A DETAIL FROM THE ENGINEER CORPS, TO MAKE SURVEYS, TO DETERMINE THE FEASIBILITY OF SUCH A WORK, ITS MOST ADVANTAGEOUS ROUTE, AND AN APPROXIMATE ESTIMATE OF ITS COST, AND REPORT THE SAME TO THE SAID DEPARTMENT.

GENERAL: The joint committee of the legislature of Maryland, on behalf of their State, and I am sure I may say of Delaware, so well represented here by her governor, in the recess of her legislature, desire, through their chairman, to express their thanks for the prompt audience you have given them on the subject of their mission. We have been instructed to seek this hearing, general, that we might ask of your department a detail from the Corps of Engineers, to make surveys for a ship-canal across the peninsula of Maryland and Delaware, to connect the waters of the Chesapeake and Delaware Bays. There is nothing new in the suggestion of such work. It has been often made, and for many years the intelligent portion of the populations of both

States have looked to its undertaking and accomplishment, under the developing influence of the necessities of trade, as a fact which must sooner or later occur. These necessities, under the rapid strides of progress, refuse to be longer denied their just demands, and it is in obedience to such high behests that we are before you. The demands of trade have ever spoken in clear and unmistakable language, and refused denial of the advantages claimed as proper and necessary for its accommodations. In these demands the young giant of the West, now attained to the stature of manhood, and rapidly progressing to the maturity of riper age, joins with our States of the Atlantic board in requiring a way of easy and ready access to the ocean, that, in common with us, he may be admitted to equal participation in the commerce of the world. Shall requests so reasonable, though urgently pressed as they should be, be denied? Our State, as may be gathered from her legislative history for a period of nearly two-score years and ten, has looked with steady and undoubting anticipations to the accomplishment of her works of internal improvement for the consummation of this great purpose. At last we are able by our system of railroads to throw wide open our doors, with the latch always upon the outside, and bid the giant of the West welcome to our domiciles; most cheerfully we accord him a pathway across our territory to the sea-board.

We have not made this invitation an empty thing that cannot be accepted, but have smoothed the path and provided the way by which we can have the enjoyment of his good company to breakfast, and, if he will not tarry longer with us, by which he can return to his own household to tea. This is no sketch of fancy, general, but is fast becoming an every-day experience. The great West lies upon the outskirts of Maryland and Delaware; and Maryland, having with that great territory a common interest, is fast beginning to realize the agreeable and profitable fact that she is the nucleus around which center, in the bond of a common interest, the South and the West, the Southwest and the Northwest; and, from her geographical position, holds relations with the North and the East which must be promotive alike of friendly connections and extensive and advantageous trade. Shall we let the little narrow strip of land between these two great bays be longer a barrier in the way of easy access to the ocean, to the immense trade of a territory constituting in its vastness a great empire, and which finds its most natural outlet to the markets of the world through the waters of the Chesapeake? This trade, already swollen to large proportions, but as yet in its infancy, must pass through Baltimore, and it thus becomes a matter of national importance, in which more than half the States of this Union are interested, that Baltimore should be brought near to the ocean by the shortest possible line of connection. Baltimore, within comparatively a few years, has grown to be a great city, claiming to rank among the leading cities on this continent in enterprise, in wealth, in commerce, in manufactures, in arts, and in all the elements which enter into and constitute a great emporium. Near the head of a great estuary, the boldest indentation of water on the Atlantic board, her locality is fixed and stable, and perhaps more advantageously, with reference to the great trade-centers of the country, than any other that could have been selected. The only disadvantages under which she labors from her position, arise from insufficient depth of water from her docks to the mouth of the Patapsco and her remote distance from the ocean; fortunately these can be overcome by proper application of means and the engineering skill of the age; and in the already increased depth of water which has been secured, and the facility with which the Patapsco is now navigated by the Berlin steamers of twenty-five hundred tons burden, we have the evidence of what can be accomplished, and of how entirely these obstacles in the way of trade are under our control.

The general government, impressed with the disadvantages of her position in these respects as drawbacks to trade, and an interference with the general commerce of the country, has recognized the removal of them as of national importance; and Congress has from time to time made appropriations, with the view of accomplishing these results. That they will be removed in a few years, we have the best guarantee in the imperative necessities of trade, and in the demand which the great West will join Baltimore in making upon the authorities of the general government for the accomplishment of this end. We have only, general, to cast the eye over the map which I hold in my hand, and glance at the routes of our great work of internal improvement, the Baltimore and Ohio Railroad, and its branches and communications, to feel ourselves sustained in these statements, and to be made sensible that they are not mere conjectures, but realities arising from existing facts.

I desire to call your attention to the distance between the city of Baltimore and the great centers of trade, to which I would attract your observation, as compared with the relative distances of the same points from the city of New York. Chicago, Illinois, is distant from Baltimore, via the Baltimore and Ohio Rrailroad, 795 miles; from New York, via New York Central Railroad, 980 miles; via Erie Railway, 961 miles; and via Pennsylvania Railroad, 899 miles; nearer to Baltimore than to New York by average distance of 152 miles. Saint Louis, Missouri, distant from Baltimore, via Baltimore and Ohio Railroad, 929 miles; from New York, via New York Central Railroad, 1,167

miles; via Erie Railway, 1,201 miles; and via the Pennsylvania Railroad, 1,050 miles. Nearer to Baltimore than to New York by average distance of 210 miles. Louisville, Kentucky, is distant from Baltimore, via Baltimore and Ohio Railroad, 696 miles; from New York, via New York Central Railroad, 989 miles; via Erie Railway 987 miles; and via Pennsylvania Railroad, 851 miles. Nearer to Baltimore than to New York by average distance of 246 miles. Cincinnati, Ohio, distant from Baltimore via Baltimore and Ohio Railroad, 589 miles; from New York, via New York Central Railroad, 882 miles; via Erie Railway, 861 miles; via Pennsylvania Railroad, 744 miles. Nearer Baltimore than to New York by average distance of 240 miles. Pittsburgh, Pennsylvania, is distant from Baltimore, via Baltimore and Ohio Railroad, 327 miles; from New York, via the Pennsylvania Railroad, 431 miles. Nearer to Baltimore than to New York by 104 miles. The proximity of Baltimore to the principal centers of trade, secured by the advantages of locality, and the sagacity and able and far-reaching management of our great work of internal improvement, the Baltimore and Ohio Railroad, give to these important points, in the economies of transportation and trade, advantages greater in these respects than they can enjoy by shipment to other points. Besides, we have other important works, the Northern Central Railroad and the Great Pennsylvania Central, especially its branches and its connections recently formed to the south of us, which bring a large amount of produce and trade to our city. Properly estimating the advantages of low port charges and economical transportation, the New York importer, when he proposes to supply with coffee the vast region over which these works extend, consults the economies of trade, and orders his ship to Baltimore, and not to New York. These statements and these figures, general, bespeak more eloquently than any language I could hope to employ the national character of the work for which it has been made our agreeable duty to ask your consideration.

And having, I trust, sufficiently demonstrated this, we desire next to ask your attention to the difference in distance from Baltimore to the European ports, and to New York, Boston, and other northern ports, by the present route and by that which we shall hope to see before many years accomplished, in the construction of the proposed ship-canal. In referring to these distances, we desire to be regarded as speaking approximately only, as we have not the data to enable us to do so with accuracy. The distance from Baltimore, by our bay, to the capes, is from 190 to 200 miles. Having passed the capes, a ship bound either for a European port or for New York or Boston, has to run on a line somewhat parallel to our coast for the distance of about 100 miles, before she lays her course for either of the ports indicated, thus making the distance of something over three hundred miles before she reaches the point of the ocean from which she may be regarded as fairly on her way to Europe or the ports to the north of us. By the proposed canal, which should be cut and constructed, without reference to cost, by the shortest line between Baltimore and the ocean, I do not think the distance, as near as can be arrived at by the inaccurate means of measurement at my disposal, will exceed one hundred and eighteen miles, thus making the saving in distance 182 miles, which figures correspond with the views of a distinguished gentleman, who, as expressed to me, has given the subject a great deal of attention. (I refer to Mr. Garrett.) You ask me, general, as to the locality of the route; pardon me; I, of course, have my views in regard to it, but wish the engineers to be entirely free and untrammeled, and if I had control of the survey, would give them but the one direction, which I have suggested. This saving in distance is not only important as saving in time and controlling the delivery of freight at its point of destination, some fifteen hours in advance of the time by the present route, but, in economy, is of not less importance to the owners of large and expensive steamships.

For illustration, we will take a large-class ship of the Allan line, whose consumption of fuel is from one hundred to one hundred and fifty tons every twenty-four hours, and whose expenses, in round numbers, may be set down at a thousand dollars a day, wear and tear of the ship, and consequent impairment of principal considered.

The saving in distance of one hundred and eighty-two miles, equivalent in saving in time to about fifteen hours, would be an economy of $625, either to the ports to the north or to European ports, which, allowing twelve trips to be made each way, or twenty-four crossings of the ocean in a year, would amount to $15,200, equivalent to more than a three per cent. interest on a capital of half a million of dollars invested in the ship.

With your permission, general, in connection with the ship-canal, we will invite your attention to some few reflections on the use and consumption of coal used in the propelling of steamers, as entering largely into the economies of transportation and commerce.

The great ocean steamship companies of New York are supplied with coal from the Cumberland mines, brought by the Baltimore and Ohio Railroad to Baltimore, and shipped thence to New York, at a cost for freight of $2.50 per ton. The steamships, therefore, from Baltimore to European ports, using eight hundred tons, save, as compared with those of the same class running from New York, $2,000 on each voyage. To the advantage of the economies thus secured, we must not forget to add that, per-

haps the most important of them all, the economy and advantage in the use of the Cumberland coal for steam-generating purposes over all other coals yet brought into general use; and for the tests on this subject, I desire to refer to a statement in the American, of the 5th of May, 1871, extracted from the Springfield, Massachusetts, Republican, of the 28th of April of the same year, in which, after prefacing remarks on the subject of coals, it is stated that experiments have been made in the national armory at Springfield, with a view of testing and arriving at their comparative values, and that the following facts were established as the results of these experiments, which are stated to have been made by Colonel Benton.

He had each of three different kinds of coal used for six consecutive days, in making steam for the engine of that establishment; first, the Lackawanna, or the hardest of anthracite coals; second, the Pittston, or softer anthracite; and third, the Cumberland, or bituminous coal of Maryland. The results were as follows: Of the Lackawanna coal, the number of pounds used, per horse-power per hour, was 4.01 pounds; of the Pittston, 4.02; of the Cumberland, 3.03. The coal cost at the armory, Lackawanna, $8.50 per ton of 2,240 pounds, or $0.00379 per pound; the Pittston, $8.75 per ton, or $0.00396 per pound; the Cumberland, $9.10 per ton, or $0.00406 per pound; which would make the cost of the coals, per horse-power per hour, as follows: Lackawanna, $0.151979; Pittston, $0.159192; Cumberland, $0.123028.

Of course these figures make clear the fact that, even at a higher price per ton, the bituminous or soft coal is the more economical, making more heat and creating more power per pound and per cent. of cost than the harder coals. Some statistics from another source indicate that, while one pound of Cumberland coal evaporates ten pounds of water into steam, a pound of the New Castle (English) coal evaporates but 7.90 pounds of water, the American anthracite 7 pounds, English Staffordshire 6.40 pounds, and dry pine wood 3.10. These experiments show too clearly to require comment the superiority of the Cumberland coal over those with which it was tested (and they have been regarded as among the best), and the great economy in its use. This economy is greatly enhanced when this coal is delivered at the docks in Baltimore at very much less cost than any other, and without the added cost of transportation to Springfield and other points. Where Cumberland coal is used in propelling machinery, it has been found that the boiler will last at least a third longer than where anthracite coal is used. These statements, which have been made with reference to the mercantile marine of our country, apply with equal or greater force to the large ships of our Navy. Then, general, let our government pursue the wise policy of deepening the channel of the Patapsco to its mouth, and bringing Baltimore fifteen hours nearer in time to the ports of Europe and to those of the northern section of our own country by the proposed ship-canal, and in a few years the impost revenue received by the Federal Government at this port will be increased from nine to twenty millions of dollars a year, and the saving to the government in the economies of time and wear and tear of vessels and machinery will be greatly more than sufficient to construct this important national link.

Thanking you again, general, for your very courteous attention to our statement, and to the detail of our remarks, which have been unavoidably somewhat tedious, and for the interest you have been pleased to express in the object of our mission, we will leave the subject in your hands, in the full confidence that it will receive the consideration to which its merits and importance as a great national question justly entitle it.

REPORT OF MAJOR WILLIAM P. CRAIGHILL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE, No. 399 DRUID HILL AVENUE,
Baltimore, Md., March 25, 1872.

GENERAL: I have had the honor to receive, with directions to report thereon, a copy of a resolution of the House of Representatives of 11th of March, 1872, in the following words, viz:

"FORTY-SECOND CONGRESS, SECOND SESSION,
"*Congress of the United States, in the House of Representatives, March* 11, 1872.

"On motion of Mr. SWANN,

"*Resolved*, That the Secretary of War be requested to communicate to Congress any information he may have upon the subject of the construction of a ship-canal from the waters of the Chesapeake to the waters of the Delaware Bay, and to state how much time would be saved by such improvement in the passage of ships from Baltimore to and from Liverpool and other foreign ports, and whether the building of such canal would not materially advance the interests of commerce.

"Attest:

"EDW'D MCPHERSON, *Clerk*."

Until a careful survey and comparison of lines for the proposed canal have determined its location, and consequently its length, it will be impossible to say with precision "how much time would be saved by such an improvement in the passage of ships from Baltimore to and from Liverpool and other foreign ports."

This question, and the other question of the resolution of the House of Representatives, viz, "Whether the building of such canal would not materially advance the interests of commerce," are treated at some length in the attached copies of communications, to which attention is invited. One of these was made to yourself on the 29th of February by the Hon. James T. Earle, of the joint committee of the legislature of Maryland, on behalf of that State, and of Governor Ponder, of the State of Delaware. The other is a letter, dated March 22, 1872, from Mr. A. Harris, who is the agent in this city of several lines of steamships.

The following resolution was adopted by the National Commercial Convention, which assembled in this city last autumn:

"*Resolved*, That Congress be memorialized to direct a survey to be made between the Chesapeake and Delaware Bays, for the proposed improvement; and, if found to be practicable, desirable, and valuable to the great interests of the country, that the said ship-canal shall be constructed."

It is apparent from an inspection of a good general map that a canal connecting the two bays, as proposed, would materially shorten the distance from Baltimore to and from Liverpool and many other foreign ports, as well as those on our coast north of Baltimore.

The papers herewith estimate this distance as 182 miles each way, or 364 miles each trip. An examination of the maps in this office lead me to conclude that the estimate is not far from accuracy. As before stated, the exact saving of distance can be only settled after a survey and location of the line of the canal.

The commercial advantages of the proposed canal seem sufficiently set forth for present purposes in the communications hereto attached. No reliable estimate of the cost of constructing the canal can be given without careful preliminary surveys. The length of line will probably not be less than 30 nor exceed 55 miles, depending on the location. The character of the country through which the canal would pass, by any proper route that might be selected having the proposed object in view, is favorable for such a work.

Should Congress determine to authorize the surveys necessary for deciding as to the location and cost of the work, it is recommended that an appropriation of not less than $20,000 be made for that object.

It may not be superfluous to add that a canal is already in existence, connecting the head of Chesapeake Bay via Elk and Back Rivers with the Delaware River at Delaware City; but this has neither depth nor width enough for the accommodation of steamers or sailing-vessels designed to cross the Atlantic. Whether, considering the objects to be accomplished, the location of this canal is admissible, even if deepened and widened, is a question for determination after the completion of a survey and estimates.

Very respectfully, your obdient servant,

WM. P. CRAIGHILL,
Major of Engineers.

Brigadier-General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

LETTER OF MR. A. HARRIS.

95 MCCULLOUGH STREET,
Baltimore, March 22, 1872.

DEAR SIR: Responding to your esteemed favor of 18th instant, I beg to hand you herewith a pamphlet copy of proceedings of the National Commercial Convention, held in this city in September, 1871, and refer you to the preamble and resolutions relative to the proposed Chesapeake and Delaware ship-canal (page 171), and to the remarks made in connection with that subject by the Hon. Reverdy Johnson.

I can hardly hope to be able to add to the information, in regard to the proposed improvement, which is contained in the pamphlet referred to. The preamble sets forth the fact that a saving of 183 miles would be effected in the distance between Baltimore and the principal ports of Europe, and it should be kept in mind that the route for sea-going vessels between Baltimore and the ports of New England would be shortened to the same extent. To accomplish this result, a canal of only 32 miles length is stated to be required. The preamble characterizes the proposed work as being of national importance, and especially desirable to the West, South, Southwest, and Northwest. That Baltimore is the seaport nearest to those vast regions, and

consequently the proper commercial outlet for their products, may be illustrated by the following statements of comparative distances, by rail, to Baltimore and to New York:

From Chicago, Ill.

	Miles.
To Baltimore via Baltimore and Ohio Railroad	795
To New York via New York Central Railroad	980
To New York via Erie Railway	961
To New York via Pennsylvania Central Railroad	899
Less to Baltimore than the average distance to New York	152

From Saint Louis, Mo.

	Miles.
To Baltimore via Baltimore and Ohio Railroad	929
To New York via New York Central Railroad	1,167
To New York via Erie Railway	1,201
To New York via Pennsylvania Railroad	1,050
Less to Baltimore than the average distance to New York	210

From Louisville, Ky.

	Miles.
To Baltimore via Baltimore and Ohio Railroad	696
To New York via New York Central Railroad	989
To New York via Erie Railway	987
To New York via Pennsylvania Central Railroad	851
Less to Baltimore than the average to New York	246

From Cincinnati, Ohio.

	Miles.
To Baltimore via Baltimore and Ohio Railroad	589
To New York via New York Central Railroad	882
To New York via Erie Railway	861
To New York via Pennsylvania Central Railroad	744
Less to Baltimore than the average distance to New York	240

In regard to the saving of time in the passage of ships between Baltimore and Liverpool which would be effected by the proposed improvement, the detentions to which even steamships are sometimes subjected in the Chesapeake Bay from fogs and other causes, render this difficult to estimate. It would probably be safe to state, however, that the voyages of steamers would be shortened from 24 to 48 hours, and the voyages of sailing-vessels a much longer period.

There can be no question as to whether the "construction of the proposed canal would materially advance the interests of commerce." The saving which it would accomplish for the owners of the vast fleets which, for all time, would continue to use it, would alone form no inconsiderable item of economy; but when the importance of the saving to result to the owners of the cargoes of these fleets, and to the varied interests throughout the nation which would be connected with a commerce of such magnitude, are duly considered, the difficulties and cost of construction of such a work dwindle to insignificance.

The interesting statistics, relative to the commerce of this port, which were recently furnished your office, from the office of the collector of customs, and referred to in your report concerning the improvement of the channel which bears your name, will aid in demonstrating the great utility of the improvement under consideration.

Regretting that the brief time allowed has prevented the collection of additional statistics, and hoping you will again call on me, if I can at any time assist in promoting the important object in view,

I remain, dear sir, very respectfully, yours,

A. HARRIS.

Colonel WILLIAM P. CRAIGHILL,
United States Engineer Office, Baltimore, Md.

REPORT OF MR. JULIUS STAHEL, GENERAL MANAGER OF MARYLAND AND DELAWARE SHIP-CANAL COMPANY.

NEW YORK, *October* 7, 1872.

GENTLEMEN: In accordance with your directions, as contained in the resolution passed at the last meeting of your board, I proceeded, accompanied by competent engineers, to the Eastern Shore of Maryland and the State of Delaware on a tour of exploration, with a view of ascertaining the practicability of cutting a ship-canal con-

necting the waters of the Chesapeake and Delaware Bays, and also with a view of finding out the most feasible routes, both in reference to distance and general character of the country.

In regard to the practicability of the enterprise, permit me to say that my investigations wholly confirmed my opinion that there is no obstacle in the way of its construction. On the contrary, the topography of the country and general character of the land is such as to render the work perfectly feasible. Of course my observations were general, but I have not the slightest doubt that an actual detailed survey will fully justify this opinion.

You will perceive by referring to the map that I have examined five routes, two of which I term overland routes, meaning thereby those routes which go across the peninsula without any reference to rivers, and the other three I term river routes, taking the best advantage of the three main rivers flowing into the Chesapeake Bay, viz, the Sassafras, Chester, and Choptank Rivers.

The overland routes have the advantage, as you will perceive from the statistics of this report, of being the shortest in point of distance, and at the same time this advantage is offset by two strong objections: First, it would necessitate the cutting of a canal all the way through an elevated ground, which would involve an expenditure of at least three times the amount that it would cost should we take advantage of the channels of the rivers, their tributaries, and the valleys; and, in addition, the shortness of the distance of the overland routes would also be offset from the fact that in a through-cut canal the rate of speed would have to be so much slower than that at which we could navigate the rivers that the question of time would be about the same, although the distance by the river routes would be so much greater.

To recapitulate. The river routes are the longest, but the cheapest and most practicable, and the difference in the rate of speed at which we could navigate the one or the other would make the time about the same. I am, therefore, of the opinion that either one of the three river routes would be decidedly the most practicable.

As before stated, I examined five routes, and I beg leave, briefly, to give you a general idea of each one. First, however, let me call your attention to the fact that in calculating the distance of each of these routes I have in each case measured from two objective points, viz, the starting point, Baltimore, and a point out at sea between Cape May and Cape Henlopen, at or about which point all vessels going north would have to pass, thus showing the number of miles saved by each route between Baltimore and this point off Cape May, as compared with the distance to the same point by going around the peninsula.

The first route which I explored was from Baltimore down the Chesapeake Bay to the mouth of the Choptank River, following the river up to Cabin Creek up to its head; thence with a small stream which flows into the northwest branch; thence through a valley and another small stream into Nanticoke River at Cannon's Ferry, following up this river through Seaford, Middleford, up to the head of the northeasterly branch of said river; thence connecting with a tributary of Broad Kiln Creek (at this point the waters begin to flow into the Delaware Bay) to Milton. From Milton I followed the Broad Kiln, which will have to be changed somewhat in its course and outlet, coming out into deep water at Cape Henlopen. This route is somewhat circuitous, but my object was to take advantage of the water channels, and avoid high ground as far as possible. I call this the Choptank route, and the distances are as follows:

	Miles.
Distance from Baltimore to the mouth of Cabin Creek	79
Distance from mouth of Cabin Creek to its head	3
Distance from head of creek to northwest branch	6
Distance from northwest branch to Cannon's Ferry	9
Distance from Cannon's Ferry to Seaford	4
Distance from Seaford to Middleford	4
Distance from Middleford to Milton	16
Distance from Milton to deep water	10
Distance out at sea	12
	143

	Miles.
Distance from Baltimore around the peninsula	347
Distance by Choptank route	143
Saved by this route	204

I next proceeded to examine the overland route from Queenstown, on the Chester Bay, taking a direct line to Milton. From thence I take the Broad Kiln Creek, and follow its course, as in the Choptank route, to deep water at Cape Henlopen. The country along this route, which, not being hilly, is still quite elevated, and supposing the average of this elevation to be only 20 feet (although I believe it to be more) above

low tide, you will perceive it would require excavation to the depth of 35 feet to make a cannal of 15 feet depth and corresponding width, and, as stated before, would be attended with great expense.

The distances by this route are as follows:

	Miles.
Distance from Baltimore to Queenstown	33¼
Distance from Queenstown to Milton	48
Distance from Milton to Henlopen	10
Distance at sea	12
	103¼

	Miles.
Distance from Baltimore around the Peninsula	347
Distance by this route	103¼
Distance saved by this route	243¾

Next I explored the second overland route from Queenstown, in Chester Bay, to Milford; from thence into Mispillion Creek to its mouth on the Delaware Bay. This route has the same disadvantages as the other overland route; besides, I do not think the outlet at Mispillion Creek a practicable one, for the reason that the bay is very shallow at this point, and there are many sand-bars, and it would require a channel to be dug some distance in the bay in order to get into deep water, and which channel would constantly be liable to be filled up by the shifting sand.

The distances by this route are as follows:

	Miles.
Distance from Baltimore to Queenstown	33¼
Distance from Queenstown to Milford	40
Distance from Milford to mouth of Mispillion	10
Distance from Mispillion out at sea	20
	103¼

	Miles.
Distance from Baltimore around the peninsula	347
Distance by this route	103¼
Distance saved by this route	243¾

I then examined the Chester River route, following the Chester River from its mouth up to Millington. This river is navigable now up as far as Crumpton for small steamers and vessels. This river, from its mouth to Chestertown, is broad and deep, and presents no obstacles to its navigation by a large class of vessels, and up to this point would require but very little dredging. At Chestertown the stream begins to narrow, and continues to its head, at Millington, where its width is about 100 feet. The channel is quite crooked, especially so for about four miles below Crumpton, but, however, does not present any engineering difficulties, the valley between the main banks being wide and swampy, and therefore it will be very easy to straighten the channel by dredging, and thus shorten the distance very materially and make navigation easier. From Crumpton to Millington the stream averages about 100 feet in width and 4 feet in depth. The channel is also very crooked, but the valley is from 300 to 500 feet in width. From Millington I follow Cypress Creek (a tributary of Chester River) up to its head; thence through a valley connecting with the headwaters of Duck Creek (which flows into the Delaware Bay), following the creek with some changes to its mouth. Duck Creek is navigable for small vessels drawing about 5 feet of water up to Smyrna, and although this stream is very crooked, yet it runs through swampy ground, thus giving ample room to straighten the channel. The material to be handled along this entire route where it would be necessary to excavate, either with dredge or other means, is sand, gravel, clay, or black mud. There are no evidences of rock or quicksand.

The distances on this route are:

	Miles.
Distance from Baltimore to Chestertown	50¼
Distance from Chestertown to Crumpton	8
Distance from Crumpton to Millington	6
Distance from Millington to Smyrna	13
Distance from Smyrna to mouth of Duck Creek	11
Distance from mouth of Duck Creek to sea	45
	133¼

	Miles.
Distance from Baltimore around the peninsula	347
Distance by Chester route	133¼
Distance saved by Chester route	213¾

The fifth route I term the Sassafras route, from Baltimore up the Chesapeake Bay, into the Sassafras River, up this river to its head at Sassafras; from thence by one of its tributaries and through a valley into Blackbird Creek, following the creek down to about two miles below Taylor's Bridge; from thence through low marshy ground into the Delaware River. This river, from its mouth to Georgetown, which is the head of steamboat navigation, is exceedingly beautiful, and is more like a bay than a river. Its course is very direct, and its width varying from 600 to 4,000 feet, and its depth, with the exception of a few small sand bars, is sufficient to float the largest vessels that enter the port of Baltimore. For small vessels drawing from 4 to 5 feet of water, this river is navigable four miles above Georgetown, while the river bed continues sufficient in width up to Sassafras for our canal.

Distances by this route are:

	Miles.
Distance from Baltimore to mouth of Sassafras	38¾
Distance from mouth of Sassafras to Georgetown	12
Distance from Georgetown to head of navigation	4
Distance from head of navigation to Sassafras Village	2½
Distance from Sassafras to Blackbird Creek, one mile below the village	10
Distance from there to Delaware River	8
Distance from Delaware River out to sea	50
	125¼

	Miles.
Distance from Baltimore around the peninsula	347
Distance by Sassafras	125¼
Distance saved by Sassafras route	221¾

I have thus briefly and in general terms described the different routes explored, but am prepared to give more minute explanations as may be demanded of me by the board.

While the figures as to the distances of the different routes and the number of miles saved are not far from being accurate, yet, owing to the variable depths of the rivers and the general topography of the country, it would be utterly impossible to approximate to an estimate of the relative cost of construction without first having a full and detailed survey made.

I would, therefore, recommend the board to authorize a survey to be made of several of the routes in order to determine with the least possible delay which is the best, both in reference to the saving of time, distance, and cost of construction.

The distance by each of these routes I have divided into divisions, according to the work which would be required to be done on each.

I would also state that in regard to the coast on the Delaware Bay I am satisfied that the only points it would be at all practicable to locate an outlet would be at Cape Henlopen or above Bombay Hook Landing, the rest of the coast being sandy and shallow.

In closing this report, let me say that during the whole of my exploration I was treated with the greatest kindness and attention by the authorities and residents of the peninsula. I was offered every facility in their power, and they manifested the greatest interest in the enterprise and were eager in offering their fullest co-operation.

Very respectfully,

JULIUS STAHEL,
General Manager.

To the PRESIDENT AND BOARD OF DIRECTORS
Of the Maryland and Delaware Ship Canal Company.

REPORT OF BENJAMIN H. LATROBE, CONSULTING ENGINEER OF MARYLAND AND DELAWARE SHIP CANAL COMPANY.

BALTIMORE, *July* 4, 1874.

SIR: Upon the 23d of May last I was called upon by General W. C. Brown, civil engineer, with a request from the representative of your company, who accompanied him, that I would examine the route of the canal projected by it, and surveyed by

General Brown as their chief engineer. I was also asked by you to express my opinion as to the probable cost of the work, and the time required for its completion. I felt called upon, therefore, not only to pass over the line of the survey in order to view the ground in all its features, which I did in General Brown's company, between the 26th and 30th of May, but to prepare an estimate of the excavations and other work required by an improvement of such magnitude, and without which I could not have hazarded even a conjecture as to its cost. To enable me to do this the maps and profiles of the survey were placed in my hands, and with their assistance and my recollection of the ground I have succeeded in reaching results both as to the quantity and cost, which I think may be relied upon. The labor involved has been considerable, as all the details of this work had to be studied with the utmost care; otherwise the conclusions, whether as to the plan of the canal, its mode of excavation, or its expense of construction, would have been entirely unworthy of confidence. My intercourse with your engineer was altogether agreeable, and the interchanges of our opinions as to the character and requirements of the work were free and satisfactory. We went from Baltimore to Georgetown Bridge upon the Sassasfras River by steamboat, and thence to the head of the river, a little below Kenneday's mill-dam, in a batteau, so that our view of the river was complete. We then passed by boat to the head of the pond created by the dam, and thence by land along the route of the survey to the shore of the Delaware Bay, touching the line at all important points, and making a satisfactory examination of its several features. It gives me pleasure to express my entire approval of the location of the canal, which reflects great credit upon the skill of General Brown, who explained clearly his reasons for selecting the ground chosen, and which are well exhibited in the well-executed maps and profiles above referred to. My view of the route confirmed my previous impressions as to its superiority in directness and economy of construction, over other lines to connect the two bays; and as we returned to Baltimore, via Chester River, I was still further persuaded that the Sassasfras route would prove not only the cheapest to construct, but also the most favorable in its approaches at both sides of the peninsula. The comparative straightness of the Sassafras River and its good depth of water up to Georgetown Bridge, and even somewhat higher, makes the approach upon the Chesapeake side peculiarly favorable, while on the Delaware shore the canal would debouch at Liston's Point, not far below the mouth of Blackbird Creek, where there is less obstruction from sand-bars to the entry of ships than at any other point above or below for a long distance. This last is a feature of much importance, as the comparative boldness of the water will obviate the necessity of long and expensive jetties.

An important subject of discussion between your engineer and myself was the depth and breadth of canal; and although we agreed that, in order to give the work its utmost capacity and efficiency, its dimensions should be such as to give passage to and from the ocean to every vessel which could reach Baltimore by the present route up the Chesapeake Bay; yet, to show at what increased expense such a canal would be built compared with one of less size, it was decided that estimates should be made for three different depths, viz, 15, 21, and 25 feet below low water in the Delaware Bay, as I informed you in my letter to you of the 29th of May. The labor attending the calculations for these different dimensions necessarily occupied much additional time, but they were indispensable to afford the means of proper comparisons so that the company could determine intelligently upon the plan of work, especially in reference to the capital they could command for its construction. The charters of the company from the two States of Maryland and Delaware, also requiring different depths for the canal, the first-named State calling for only 15, while the last asks for 21 feet, seemed to be an additional reason for computing for those two dimension while the third of 25 feet would show the work in its most perfect form.

With these preliminary remarks I will proceed to give the result of the estimates which I have made, without, however, having had the opportunity of comparing my views as to quantities or prices with your engineer, whom circumstances have prevented from meeting me for that purpose. Perhaps it is as well that our estimates should be made independently, so that if they in the main agree they will command greater confidence, while if it should prove otherwise your company can select and rely upon those which seem to them most likely to be correct, or as much as such estimates can claim to be when made from the best data, upon the best principles, and with the most honest intentions not to mislead the parties concerned. The work required by the projected improvement requires:

First. Excavations under water in dredging out the channels of existing watercourses to the proper depth of the canal.

Second. Excavations partly above and partly below water-level at the same points of the canal section.

Third. Excavations altogether above water-level and in dry material, although requiring drainage during the progress of the work.

The first description of excavation will consist chiefly of soft river mud, with a proportion of sand and some gravel. The second and third will be mostly or entirely

clay, sand, gravel, and probably a proportion of blue mud in the prism or bottom section of the canal. It is not expected that any rock will be met with in the excavations.

Fourth. Walling of the slopes of the canal prism where the depth of cutting exceeds about 40 feet above the level of the canal berme, which berme is 4 feet above the low-water level—when the depth becomes so great as this the excavation saved by steepening the sides of the prism of the canal is equal, as I have estimated, to the additional cost of the wall, which wall at the same time protects the sides from being washed by the waves raised by passing vessels. For depths less than 40 feet above the berme, the slope of the canal prism is $1\frac{1}{2}$ to 1, and a platform to answer as a berme is supported on piles.

Fifth. Concrete covering of the surface of the berme or offset, 4 feet above the low-water line of the canal, and at the foot of the general slope of 45° from thence up to the surface of the ground.

This berme, of a width varying $9\frac{1}{2}$ to $14\frac{1}{2}$ feet, according to the depth of canal, is indispensable, in my opinion, to receive the washing of the slopes of the canal above its surface level, and to facilitate their removal before they reach the water, out of which they would have to be dredged if not arrested by these offsets.

Sixth. Approaches at each end. These I agree with your engineer in proposing to construct of piling and heavy planking, at least at first, in lieu of jetties or piers of masonry. The pile structure will be efficient and economical, and can be replaced in future by stone-work if deemed advisable.

Seventh. Bridging.—There would be required nine highway bridges and two railway bridges, all of which must be furnished with draws, even where they occur over the deep cutting of the canal, in order to pass the masts of large ships.

Eighth. Right of way.—For the deposit of the large amount of material out of the deep cuts a considerable breadth of ground is required, ranging from $\frac{1}{10}$ to $\frac{1}{8}$ of a mile.

Ninth. Engineering, superintendence, and contingencies.—This forms the remaining item of the estimates. which are submitted, as follows:

Estimated cost of ship-canal 15 *feet deep and* 80 *feet wide at bottom, with berme* 19 *feet above bottom, and* $9\frac{1}{2}$ *feet wide.*

Excavations, 17,115,001 cubic yards, at average cost of $36\frac{3}{10}$ cents	$6,214,990
Dredging channel of Sassafras River from Georgetown Bridge to station 218 (4 miles) to an additional average depth of 5 feet by 125 feet wide; 493,000 cubic yards, at 20 cents	98,600
Walling, 2 feet thick, between stations 293 and 628, 109,185 cubic yards, at $5	545,925
Concrete covering, $\frac{1}{2}$ feet thick, 11,787 cubic yards, at $4	47,148
Estimated cost of canal proper	6,906,663
Right of way land, 1,400 acres, at $100 per acre	140 000
INCIDENTAL WORKS.	
Approaches at each end	$20,000
Nine highway bridges with draws and 80-foot openings	150,000
Two railway bridges	100,000
Draw at Georgetown Bridge	15,000
	7,331,663
Engineering, superintendence, and contingencies, 10 per cent	733,166
Total entire amount	8,064,829

Estimated cost of ship-canal 21 *feet deep and* 90 *feet wide at bottom, with berme* 25 *feet above bottom,* $12\frac{1}{2}$ *feet wide.*

Excavations, 22,281,654 cubic yards, at an average of $36\frac{38}{100}$ cents	$8,106,025
Dredging channel of Sassafras River, from Georgetown Bridge to station 218 (4 miles) to additional depth of 11 feet by 150 feet wide, 1,290,660 cubic yards, at 20 cents	258,132
Walling, $2\frac{1}{2}$ feet thick, between stations 376 and 587, 103,314 cubic yards, at $5	566,570
Concrete covering of berme, $\frac{1}{2}$ foot thick, 9,687 cubic yards, at $4	39,072
Pile platform, (between stations 293 and 376, and 587 and 628), 12,400 linear feet, at $6.06	74,896
Estimated cost of canal proper	9,044,695
Right of way land, 1,440 acres, at $100	144,000

INCIDENTAL WORKS.

Approaches at each end as in previous estimate	$20,000
Nine highway bridges with draws of 90 feet opening	170,000
Two railway bridges	110,000
Georgetown bridge draw	15,000
	9,503,695
Engineering, superintendence, and contingencies, 10 per cent	950,369
Total estimated cost	10,454,064

Estimated cost of ship-canal 25 feet deep and 100 feet wide at bottom, with berme 29 feet above bottom and 14½ feet wide.

Excavations, 26,419,443 cubic yards, at an average of 36 cents per yard	$9,649,514
Dredging channel of Sassafras River, from Georgetown Bridge to station 218 (4 miles) to additional depth of 15 feet by 150 feet wide, 1,760,000 cubic yards, at 20 cents	352,000
Walling, 3 feet thick, between stations 387 and 587, and 146 and 525, at $5	732,625
Pile platform (between stations 293 and 387, and 584 and 628), feet, linear,	
Concrete covering for, ½ foot thick, 10,740, $4	42,960
13,800, at $6.06	83,577
Estimated cost of canal proper	10,860,676
Right of way land as in preceding estimates	144,000

INCIDENTAL WORKS.

Approaches at each end as in preceding estimates	$20,000
Nine highway bridges with draws, opening 100 feet	180,000
Two railway bridges with draws, opening 100 feet	120,000
Draw at Georgetown Bridge	15,000
	11,339,67
Engineering, superintendence, and contingencies, 10 per cent	1,133,967
Total estimated cost	12,473,643

SUMMARY OF THE PRECEDING ESTIMATES.

15-feet canal—estimated cost	$8,064,829
21-feet canal—estimated cost	10,454,064
25-feet canal—estimated cost	12,473,643

In establishing prices for excavation in the above estimates the cuttings were classified as to their character, the depth of their respective parts, and the facilities for removing the material and depositing it in the spoils banks on the sides of the canal. These banks will occupy a wide space throughout the extent of the deeper cuttings, as the height of the embankments of waste material should not exceed from 10 to 20 feet, and such a margin must be left on either side of the cuttings as to prevent the spoil earth from sliding or washing back into the excavations. Hence, where the depth of cutting is the greatest (84 feet above low-water in the Delaware Bay) the breadth of land occupied must be about one-third of a mile, the required width lessening as the depth of cutting decreases. To hasten the progress of the work as much as consists with due economy, it is proposedt o remove the uppermost 20 feet in the deep cuttings by means of carts and the ordinary excavation tools, while for the next 20 feet downwards and the successive similar depths to the bottom of the canal, the steam-shovel excavator should be used; and in order to multiply the points at which they would be employed, there should be at least two capacious pits sunk at the start from the surface to the bottom, at suitable distances apart in the length of the deep-cut section of the canal. By this means the steam-machines may be made to operate at four breasts of 20 feet each in height, besides the workings at the ends, and the advance of the work will be vastly accelerated. The pits will, of course, have to be drained by powerful pumps, and the breasts upon the several levels must be kept somewhat in advance of each other from above to below, to avoid interference. It must be manifest that to expedite a work of such magnitude, and requiring the earliest possible completion in order to save interest upon its cost and begin to enjoy its commercial advantages as

soon as possible, the supply of men and machinery must be without stint, and to this end the requisite capital must be promptly furnished and the utmost reach of engineering skill displayed in devising and executing the plan of operation which should be carried on under the contract system. If all these requirements be fully met, four years should be sufficient for the work. In preparing the estimates, I, at your engineer's request, confined them to the distance of a little less than 20 miles ($19\frac{82}{100}$) between Georgetown Bridge and the Delaware Bay shore, it being assumed that the United States Government would aid the work to the extent at least of improving the Sassafras River from the bridge to its mouth at the Chesapeake Bay, a distance of about 10 miles, which, added to the distance just given, would make the length of the whole improvement 30 miles. The saving of distance to vessels sailing or steaming from Baltimore to the eastern ports of the coast above the Delaware Bay is computed to be 215 miles compared with the voyage around by the Capes of Chesapeake, and it would not be many miles less for vessels bound to European ports.

The voyage on the Chesapeake Bay from Baltimore to the mouth of Sassafras River is 36 miles, and from Liston's Point, on the Delaware Bay, to the point at which the lines of coasting voyages to New York and eastern ports would converge, 58 miles, making the whole distance from Baltimore to that point by the ship-canal 124 miles against 339 miles by the Chesapeake Bay and its capes. In order to make this large saving of distance in miles effective, it is necessary that there should be as little reduction of speed in passing through the canal as may be, and hence an ample cross-section in breadth and depth should be given to that work, not only to allow vessels to pass each other readily, but to affect their speed as little as possible. Hence they should make not less than 5 miles per hour, or four hours' time in the passage of the 20 miles, and if we allow a speed of 10 miles an hour, or 1 hour on the Sassafras for the 10 miles below Georgetown Bridge, and if we furthermore allow 12 miles an hour or 8 hours in all on the 94 miles of Chesapeake and Delaware Bay navigation, the total time in the voyage of 124 miles would be 13 hours, or, say, 14 hours, allowing for delays in entering and leaving the canal and passing the draws. The time of the Chesapeake Bay and coast voyage of 339 miles at 12 miles per hour would be $28\frac{1}{4}$ hours, showing a saving of more than 14 hours' time, which might often be increased by head-winds in the much longer voyage upon the more exposed navigation of the circuitous route. Against this advantage of the canal route must be put occasional detentions from fixed ice in the canal and running ice in the upper bay. There must of course be ample provision made to meet this difficulty by means of ice-boats, which in the climate of this latitude would not be wanted for more than a month, except in winters of extraordinary severity. It will be noticed, too, that the Chesapeake Bay voyage is not free from this trouble in such winters, although of course in a less degree than the canal route, for which due allowance should be made in comparing the two.

It must be manifest that the canal should be a tidal work without lockage, as no adequate supply of water for a summit level could be had, and the delays at locks and the cost of their construction and repair and attendance would be serious drawbacks upon the value of the improvement as a great commercial highway to and from such a seaport as Baltimore. There is a difference of about $2\frac{1}{2}$ feet in the high water of the two bays and nearly an equal difference in the times of flood, that of the Delaware being the earlier of the two; but this, in view of the length of the canal, will produce an alternate current either way quite imperceptible, and in no wise embarrassing free navigation.

I conclusion I would remark that this projected work, by no means an idea of yesterday, but a subject of interesting discussion for nearly half a century with the commercial communities concerned in it, is now acquiring a rapidly increasing interest to them, especially to the city of Baltimore, the future growth of whose northern coastwise and European trade is deeply involved in its execution. The large capital required for its construction upon such a scale as to float the largest vessels which can now enter or leave her harbor will doubtless suggest a reduction of dimensions with a view to future enlargement, or it may be proposed to make a breadth great enough to permit the passage of vessels at intervals, retaining the depth necessary to float them at all points. While this may be a practicable alternative, I cannot think it is one to be recommended, as it must be attended by a reduction of speed and by delays at the passing places, which would largely reduce the gain in time over the Chesapeake Bay route. The enlargement also would be attended with increased expense and much embarrassment to the navigation during its progress.

In regard to the early results of this work as an investment of capital, I can at present offer no positive opinion (although that which I have is favorable), nor am I called upon as an engineer to do so, especially as the communities and other parties interested in its construction have the same access that I should have to the commercial statistics upon which an estimate of income would be founded. The work, if well constructed, ought not to be costly in its maintenance and management, although the extent of deep cutting will require for some years a considerable expenditure in the removal of land slides and washes for about a third of the length of the canal. The

remaining two-thirds should cost but little in repairs, and as there would be no locks the attendance and supervision should not be expensive.

I append a sheet on which the cross-sections of the canal for different depths and breadths are shown, as well as the disposition of the spoil banks.

I am, respectfully, your obedient servant,

BENJAMIN H. LATROBE,
Civil Engineer.

HORACE B. TEBBETTS,
President Maryland and Delaware Ship-Canal Company,
Trinity Building, New York.

REPORTS OF MR. W. CULLEN BROWN, CHIEF ENGINEER OF MARYLAND AND DELAWARE SHIP-CANAL COMPANY.

1.

ENGINEER'S OFFICE, MARYLAND AND DELAWARE SHIP-CANAL COMPANY,
No. 7 Nassau Street, New York, March 4, 1878.

GENTLEMEN: In accordance with your instructions I have made an instrumental survey of the Sassafras River route for the purposes of a ship-canal, commencing the same at the draw-bridge at the village of Georgetown, in Kent County, Maryland.

I first determined the point of extreme low tide by observations continued throughout several days—mean tide, 2.6 feet. (See report of observations.) I was fortunate in selecting the time and place for observation—the weather cool and dry—the wind blowing from the east with a force of about five miles per hour, and the tide unusually low—the lowest point reached for several years, which fact I learned through old residents of the village.

These facts I regarded as being exceedingly favorable, for it was my desire to find extreme low tide as a basis upon which I could establish a datum line for running a line of levels from this point to the waters of the Delaware Bay. I assumed this line to be fifty feet below low tide as determined by observations; from it all the levels on the Sassafras River route were run, both direct and side lines.

At frequent intervals for future reference along the line as run, permanent "level benches" were established, usually upon the roots of large trees. (See level notes No. 1.)

COMMENCEMENT OF LINE.

I commenced the line of survey at the south end of the draw-bridge (see No. 1, topographical notes) and continued it across the same to the north shore of the river, along which I extended it to the headwaters of George Kennedy's mill-pond. From this point I ran another line on the south side of pond and river, down same to Alexander Wilson's house. From the head of said pond the line follows the main tributary, keeping the general course of the valley to the summit or divide between the waters that flow into the Chesapeake and Delaware Bays.

On this divide the tributary waters of the Blackbird Creek take their rise, and from this point I run two lines, one along the tributary known as Cave Branch, and the other, which I have called center line, along the tributary called Harris Branch. These two lines form a junction about one thousand feet westerly of the trestl.-bridge of the Delaware Railroad over the Blackbird Creek and Valley.

From this junction of the two aforesaid lines, the line of survey follows the Blackbird Creek and Valley to a point near Taylor's Bridge, from which I ran two lines, one following the valley of the said creek to a point known as the Red Banks; and from thence in a direct course to a small cove at Liston's Point. The general surface—salt meadow—is about 6 feet above low-tide.

The other line runs in a more direct and easterly course, crossing over a belt of upland having an average elevation of about twenty feet for a distance of about 2,500 feet; thence through low swampy ground until it arrives at a point about 4,500 feet from the bay. Here it passes across another belt of upland varying in width from 600 to 800 feet and having an elevation from 10 to 12 feet. After leaving this point the line runs across the salt meadow, which has about the same elevation as the line via Red Banks, to a large cove just below Gull Bar and Liston's Point.

In many respects the proposed route of the canal is exceedingly interesting and peculiar. The Sassafras River is broad and beautiful for a distance of about 16 miles, its course nearly east and west, and lies in a broad valley, whose banks rise to a general elevation above mean tide of about 40 feet. The valley is overflowed by high tide, which fact furnishes an abundant way for the flow of water.

With the exception of a few sand bars (see United States Coast Survey charts) there

is a sufficient depth of water in the river for a distance of 12 to 13 miles to float any vessel that would pass through the canal when constructed. From this point to the head (at Sassafras Village) the river lessens in width and volume, but the valley continues broad; indeed, it holds its width remarkably well to the summit.

From Sassafras to the mouth of the river the surface of the valley is usually covered with high tide; there being so much water-way and volume of water that large-class vessels can run at as great speed as in the waters of the bay.

These views will hold true in regard to the eastern division to a great extent; indeed, I think there will be no necessity of slowing vessels except for a few miles through the center division. This is a very important consideration, for the time of a vessel is an important element in commerce.

FLOW OF TIDE.

Extreme high tide flows from the Chesapeake Bay to the foot of George Kennedy's mill-dam at the village of Sassafras (ordinary tide to a point about 2,000 feet below) from the Delaware Bay to the village of Blackbird, thus leaving a distance of only 8 miles between tides. But a slight effort further on the part of natural causes would have cut the peninsula in twain at this point.

STATEMENTS OF CITIZENS.

It is stated by citizens living in Sassafras that about sixty years ago vessels from 200 to 300 tons burden sailed from each bay to points within six miles of each other. Judging from the mud soundings I made in channels, I accept these statements as reliable.

WATER SHED.

Upon this point there is nothing to fear. The surface of country that drains itself into the valleys of the Sassafras River and the Blackbird Creek is generally level; in places gently undulating, cut occasionally by ravines that have evidently been formed by long and continued washings. These, however, intersect the main valleys at the same elevation, and hence can be easily controlled.

DISTANCES.

	Miles.
From mouth of Sassafras River to the village of Georgetown	12½
Georgetown to Sassafras Village	4.8
Sassafras to Blackbird Village	7.7
Blackbrid to Delaware Bay (Liston's Point)	7.4
Total	32.4

ROAD CROSSINGS.

At Georgetown there is a very good carriage-road bridge, with a pivot draw, giving two openings of 47 feet each. This bridge will serve the purposes of the canal for the present. It is the property of the two counties, Kent and Cecil, and will have to be maintained by them.

The other carriage-road crossings are located as follows:

One on the summit, middle division.
One on the western slope, middle division.
Two on the eastern slope, middle division.
One at Blackbird, eastern division.
One at Blackbird landing.
One at A. Ennis's landing.
One at McLain's, eastern division.

RAILROAD CROSSINGS.

One, Delaware Railroad, at Blackbird.
One, Kent County Railroad, near summit.

The number of bridges for carriages can be lessened by changing the roads so that one bridge will answer for two or more roads.

CHARACTER OF MATERIAL.

Under this head it is impossible to give positive information, for the reason that I have had neither the time nor opportunity to make a thorough examination by sinking wells or test holes. I have been able, however, to examine the banks bordering the streams; have also learned of the character of material from citizens who have sunk well along the line at various points, which vary in depth from 10 to 50 feet. Estimating from this data, together with the surface indications, slopes of banks, mud soundings, general geological rules applying to the formation of this part of the peninsula, I am of the opinion that 75 per cent. of all the material to be handled in constructing the canal will be composed of sand and gravel; the balance will be clay, black mud with a mixture of sand, shell, &c.

CLASSIFICATION.

All that portion of material within the prism of the canal lying and being above high-tide line can be economically handled by steam excavators. That part lying below said point can be very successfully worked with steam dredging machines.

DEPOSIT OF MATERIAL.

There are places at frequent intervals along the line and within reasonable distances where the material can be deposited and without danger of either pressing in the banks of the canal or of being carried back by the action of weather or storms.

The entire work will be inland, and hence there will not be the usual delay in working dredging machines that occurs in an open sea. This fact alone will contribute materially to the economy both in time and money in doing the work.

In conclusion, allow me to say that the survey has not only established the fact that this route or line is far preferable to the other four routes examined carefully by me in accordance with your instructions, but has developed so many important features and favorable characteristics of route for a ship canal, that I feel justified in advising that you have located this route according to the terms of your charters, it being the only practicable route for a large ship canal without locks crossing the peninsula.

Herewith you will find maps, profile, and approximate estimates of the quantity of material to be moved in excavating canal.

Respectfully submitted.

W. CULLEN BROWN.

To the PRESIDENT AND DIRECTORS.

2.

NEW YORK, *March* 15, 1878.

DEAR SIR: In accordance with your instructions to me, given on the 10th instant, I have estimated the number of cubic yards of material to be removed in constructing the canal between station numbers 240 and 1053. The distance between said stations is 81,300 feet, or 15 39-100 miles. (See map and profile.)

My estimates are based upon the supposition that the material to be excavated is as set forth in my previous report of March 11, and, further, upon the dimensions specified in your instructions to me. See cross-section map for summit, herewith submitted, by which is shown that the prism of the canal at bottom is 40 feet; slopes of prism banks 1½ to 1 foot below the berme; same slopes above the berme. Depth of canal below low tide 21 feet; height of berme above bottom, 30 feet; or 9 feet above low tide.

According to the dimensions, there are 22,840,179 cubic yards.

If your company should change the slopes to 1′ to 1″ the cubical quantities would be reduced below 20,000,000 cubic yards.

In answering your inquiries in relation to lands for right of way and for depositing the surplus material taken from the canal, I most respectfully recommend that the company purchase at least 1,400 acres for said purposes, and that a large portion of the same be selected at and near the eastern end of the canal. These lands can be made desirable and valuable by the improvements that will necessarily be made in constructing the canal, and will be of very great value to the Canal Company after the canal is finished. I think the average cost of these lands will not exceed the sum of $45,000 per acre.

Respectfully submitted.

W. CULLEN BROWN,
Chief Engineer.

HORACE B. TEBBETTS, *President.*

JOINT RESOLUTIONS OF THE GENERAL ASSEMBLY OF MARYLAND, 1878.

Whereas the States of Maryland and Delaware heretofore chartered the Maryland and Delaware Ship-Canal Company for the purpose of constructing a ship-canal across the peninsula of Maryland and Delaware, connecting the waters of the Chesapeake and Delaware Bays, and opening a direct route to sea for vessels trading at the ports of Baltimore and the upper part of the Chesapeake Bay, thereby shortening the distance from Baltimore to European ports, and New York and New England seaboard cities, 225 miles, and avoiding the dangerous and tedious route doubling Cape Charles, and by said charter said company is authorized to charge a rate of toll not exceeding 20 cents per ton;

And whereas this general assembly approves the wisdom and foresight of the said general assemblies of Maryland and Delaware which granted said charter, and deems the speedy construction and opening of said canal of paramount importance to the growing commerce of Baltimore and the great agricultural sections of the Southwest, the West, and the Northwest, which find their nearest and natural outlet at Baltimore City;

And whereas the said canal would afford the cheapest and most effectual means of defending the cities of Washington, Baltimore, and Annapolis on the south side, and Philadelphia, Chester, Wilmington, New York, and the New England seaports on the north side in case of war, by enabling the naval forces of the United States freely and speedily to pass from bay to bay, and on interior lines to pass up the Atlantic coast for the defense of threatened points, and would also enable merchant shipping to retreat from one bay to the other in case of danger from a hostile fleet;

And whereas the Federal Government is charged with the public defense, and it is its duty to adopt the most complete modes of rendering the capital of the United States and the great seaboard cities impregnable, and the interests heretofore mentioned are of national, and the construction of said canal of international importance;

And whereas private individuals are about to take upon themselves the construction of this great work, and are seeking to obtain the necessary means to insure its successful completion: Now, therefore,

Be it resolved by the general assembly of Maryland, That the Representatives and Senators from Maryland in the Congress of the United States are hereby requested to urge upon the Congress of the United States to grant unto the said Maryland and Delaware Ship-Canal Company such aid as may be necessary to insure the completion of said canal, in consideration that the said company will permit the vessels of the United States Navy, or its transports, at all times, to pass through the said canal, when completed, free of all tolls and charge.

And be it resolved, That the governor of Maryland be, and he is hereby, requested without delay to transmit a copy of these resolutions to each of the said Representatives and Senators from Maryland.

FETTER S. HOBLITZELL,
Speaker of the House of Delegates.
EDWARD LLOYD,
President of the Senate.

Attest:
M. Y. KIDD, *Chief Clerk.*

CHAPTER 336.—AN ACT to incorporate the Maryland and Delaware Ship-Canal Company.

SECTION 1. *Be it enacted by the general assembly of Maryland*, That Horace B. Tibbetts, George Vickers, C. Bainbridge Smith, Thales A. Linthicum, James T. Earle, Philip W. Downs, E. L. F. Hardcastle, Levin Woolford, John W. Davis, Julian J. Alexander, James T. Briscoe, and their associates and successors, and all other persons who may be stockholders, as hereinafter provided, are hereby constituted and made a body corporate, by the name of the Maryland and Delaware Ship-Canal Company, for the purpose of cutting and making a ship-canal, the object of which shall be to connect the waters of the Chesapeake and Delaware Bays, with all the works, locks, offices, and appurtenances that may be necessary. The said canal shall start from or commence at some convenient point on the Chesapeake Bay, or on some of the rivers, estuaries, creeks, or arms of the same or emptying into the same, but not above Sassafras River, and run to the State line of Delaware and Maryland, and by the aforesaid corporate name the said Horace B. Tibbetts, George Vickers, C. Bainbridge Smith, Thales A. Linthicum, James T. Earle, Philip W. Downs, E. L. T. Hardcastle, Levin Woolford, John W. Davis, Julian J. Alexander, and James T. Briscoe, their associates and successors, and all other persons who may be stockholders, as hereinafter provided, shall be and they are hereby made capable in law of purchasing, holding, leasing, selling, conveying estates, real, personal, and mixed, so far as shall be necessary and convenient for the purpose aforesaid, and hereinafter mentioned, and no further, and shall have perpetual succession, and by said corporate name may sue and be sued, and

have and use a common seal and the same alter and renew at pleasure, and also to ordain, establish, and put in execution such by-laws, ordinances, and regulations as shall seem necessary for the government and management of said corporation, and to alter and repeal the same at pleasure, and shall have and exercise all the rights, powers, and privileges which corporate bodies may lawfully possess for the purposes mentioned in this act.

SECTION 2. *Be it further enacted*, That the capital stock of said corporation shall be $2,000,000, to be divided into shares of $100 each, which said capital stock shall be personal property and shall be transferable in such manner as the by-laws of said corporation may prescribe; and the said corporation, whenever it shall seem to the directors thereof necessary or expedient for the purpose contemplated by this act, shall have power also to issue and sell on the best terms that can be obtained for the same, the bonds of the said company in such sums as may be convenient, payable after such a number of years as may be deemed proper, and bearing in the meantime interest at the rate of 6 per centum per annum, provided that the gross amount of said bonds so issued by said company shall not exceed the sum of $4,000,000; and for the purpose of securing the payment of the principal and interest of said bonds, the said company may execute and deliver a mortgage or mortgages of the said canal, and of all other estate that may belong to it, or may convey the same by deed to such trustees as may be appointed upon such trusts as may be reasonably advised or devised for said purpose of securing the payment of principal and interest of said bonds.

SECTION 3. *And be it enacted*, That the said Horace B. Tibbetts, George Vickers, C. Bainbridge Smith, Thales A. Linthicum, Julian J. Alexander, James T. Briscoe, James T. Earle, Philip W. Downs, E. L. F. Hardcastle, Levin Woolford, and John W. Davis, shall be, and they are hereby, constituted commissioners to receive subscriptions to the capital stock of said company, and they, or a majority of them, are hereby authorized to open books for the purpose of receiving subscriptions to said capital stock, and shall designate the time and places of which said subscriptions shall be taken by giving one week's notice thereof in one or more newspapers published in the city of New York, the city of Baltimore, and in the State of Delaware; and in case more stock is subscribed than is necessary to the full and ample completion of said canal, the said commissioners shall apportion said subscription among the stockholders in such manner as they, or a majority of them, shall deem to the interests of said corporation; and if any subscriber or owner of said stock shall fail to pay any assessment which may be required by the president and board of directors of said company for the space of sixty days next after the same is called for and made payable, the stock upon which such assessment is required shall be forfeited to the company and may be sold by the president and said board of directors for the benefit of said company; but said president and board of directors may remit such forfeiture upon such terms as they may think proper; provided, however, that no stockholder shall be assessed for any purpose more than the par value of his stock.

SECTION 4. *And be it further enacted*, That as soon as the sum of $100,000 of the capital stock of said corporation shall have been subscribed and 5 per centum on the said sum of $100,000 shall have been paid in, the said commissioners shall call a meeting of the stockholders by giving ten days' previous notice of the time and place of said meeting in one or more newspapers printed in the city of New York, the city of Baltimore, and in the State of Delaware, and said stockholders shall elect by ballot at such meeting, or at any subsequent general meeting of said stockholders, seven directors of said corporation, all of whom shall be stockholders in said corporation, who shall hold office for one year from the day of their election, and until their successors shall be elected and qualified, and to conduct and manage the affairs and business of said corporation; and said stockholders shall each be entitled to one vote for each share they shall have and hold at the time of said election; and such election shall be made by each of the stockholders as shall attend said general meeting, either in person or by proxy; and the directors of said corporation, except for the first year, shall be annually elected, and at each time and place as shall be directed by the by-laws of said corporation.

SECTION 5. *Be it further enacted*, That the directors so elected shall as soon after their election as practicable elect one of their number president of said corporation; and the said president and directors, or their successors in office, or a majority of them assembled, shall have full power and authority to appoint, and at their pleasure dismiss, such clerk, treasurer, engineer, or engineers, and such other agents as they may deem expedient, and to fix their compensation; and to agree with any person or persons on behalf of the said company to cut said canal, erect dams, open feeders, make cuts, construct locks, and such other works as they shall judge necessary or expedient for completing said canal, and to repair and keep the same in order.

SECTION 6. *Be it enacted*, That when any vacancy or vacancies shall occur in the board of directors of said company by death, resignation, or otherwise, the remaining directors shall choose others in their stead from the stockholders of said company, who shall continue in office until the next general election of directors.

SECTION 7. *Be it enacted*, That the said president and directors, or their agent or agents authorized by them, may agree with the owner and owners of any land, earth, gravel, stone, timber, materials, streams, or any improvements which may be wanted for the proper construction or repair of said canal or any of its works, for the purchase and use and occupation or diversion of the same; and if they cannot agree, or if the owner or owners of any of them be an infant, feme covert, who is not possessed of the property to her sole and separate use, or authorized to contract in reference to the same, non compos mentis, or out of the county where such property wanted may lie, when such property may be wanted, or for any other cause be legally incapable of contracting, application may be made by the said company to any justice of the peace of such county, who shall thereupon issue his warrant under his hand and seal to the sheriff of the county, requiring him to summon a jury of twenty of the inhabitants of said county, above the age of twenty-one years, not related to the parties, nor in anywise interested, to meet on the lands or near the materials or other property wanted on a day named in said warrant, not less than ten nor more than twenty days after issuing the same, and if at said time and place any of the said jurors summoned do not attend, the sheriff shall immediately summon as many persons similarly qualified as together with those in attendance will furnish a panel of twenty jurors in attendance, and from the panel each party, his, her, its, or their agent or attorney, or if either party be not present in person or by agent, or, being present in person or, agent, refuse to strike, the sheriff, for him, her, it, or them, may strike off four persons, and the remaining twelve shall act as the jury of inquest of damages, and to each, before he acts as such juror, the sheriff shall administer an oath or affirmation that he will justly and impartially value the damages which the owner or owners will sustain by the use and occupation of the property required by the said company, and also the benefits or advantages to accrue to the owner or owners by the construction of the said canal as a set-off to the said damages, but only in extinguishment of the claim for damages, and not for the actual value of the land or other material taken, and after having made a fair and just offset of the advantages and disadvantages arising from the construction of the said canal, they shall estimate and determine what amount of damages has been or may be sustained by the said owner or owners, respectively, and the said jury shall reduce their inquisition to writing and sign and seal the same, and it shall then be returned by the sheriff to the clerk of the circuit court for his county, and be filed by said clerk in his office and shall be confirmed by said court at its next term or session, if no sufficient cause to the contrary be shown, and when confirmed shall be recorded by said clerk at the expense of the company, but if the same be set aside the said court shall direct another inquisition to be taken in the manner above described, and in case of the second or any other inquisition which is confirmed by the court shall not award to the land owner a larger amount of damages than was awarded by the first inquisition, the court may in its discretion order the cost of said second or other inquisition to be paid by the owner or owners of said land or materials condemned, and the inquisition shall in all cases describe the property taken or the bounds of the land condemned, and the quality or duration of the interest in the same valued for the company; and such valuation when paid or tendered to the owner or owners of the property his, her, or their legal representatives, shall entitle the said company to the estate and interests in same thus valued as if it had been legally conveyed by the owner or owners of the same, and the valuation if not received when tendered, may at any time thereafter be recorded without costs from said company by the owner or owners, his, her, or their legal representatives, and the sheriff shall keep the said jury together for a reasonable time until they shall agree upon and sign and seal the said inquisition; and in case it shall so happen that the jury cannot agree after being kept together as aforesaid, the sheriff may in his discretion discharge the said jury and without any further warrant from a justice of the peace shall within five days thereafter summon another jury of twenty inhabitants as aforesaid, not upon the former jury, and the same proceedings shall be had in all respects as is herein before provided, and in case of a second or other disagreement of the jury the same proceedings shall be had until a verdict or inquisition shall be made and returned as aforesaid; and wherever the said canal shall cross or pass any road or roads of what kind soever the said company shall build or erect and maintain in good order proper swing or draw bridges, or other bridges, such as are commonly used where a railroad crosses a navigable stream over and upon said canal, so that passage over the same may not be impeded or interrupted.

SECTION 8. *And be it enacted*, That nothing contained in this act shall authorize said company to take private property for their use without just compensation as agreed upon between the parties or ordered by a jury, being first paid or tendered to the party or parties entitled to such compensation.

SECTION 9. *And be it further enacted*, That the said canal so constructed under this act shall be of the dimensions as follows, at least 15 feet deep and 60 feet wide upon its surface, and 40 feet wide at the bottom thereof, unless, at such points and places where the character, position, and formation of the soil may render it impracticable to make it of such dimensions.

SECTION 10. *And be it further enacted*, That if the said capital stock shall prove insufficient to accomplish the object of this act it shall be lawful for the said company, from time to time, to increase the same to the sum of $4,000,000 by receiving additional subscriptions to said capital stock, which shall be done in the same manner as to notice above and otherwise as is provided in this act for the original subscription to said stock.

SECTION 11. *And be it further enacted*, That the said company are hereby authorized to establish a tariff of tolls for the navigation or use of the said canal, or any part thereof, and the same to alter at their pleasure, provided the said tolls shall not exceed 10 cents per ton.

SECTION 12. *And be it further enacted*, That for the purpose of securing the complete opening of the ship-canal so as to connect the waters of the Chesapeake and Delaware Bays, the said company shall have power and authority to enter into such contract or contracts, upon such terms and conditions as may seem proper and expedient, with any other corporation or person or persons whatsoever having authority to cut or make any canal or canals in the State of Delaware in order that a connection may be made with such canal or canals, and the object and purposes of this act be more fully carried out, and thereupon, on such connections being made, that the said continuous canal and canals, and all and singular its and their appendages and appurtenances may be used and employed by the said company so far forth as the authority of this State may extend to give any needful power thereof, as if such other canal or canals lay wholly within the limits of this State, and such contract or contracts as aforesaid were made with the full approbation of the general assembly of Maryland.

SECTION 13. *And be it further enacted*, That the said company shall have power and authority to purchase or hire or build and construct steamships of such capacity as may be desirable for the purpose of towing vessels through the said ship-canal or for carrying freight or passengers from any port to any port through the said ship-canal, or for carrying and conveying passengers or freight that may be transshipped at either of the terminus of said ship-canal upon such vessels, or for carrying and conveying passengers and freight for transshipments through the said canal upon other vessel or vessels; and the said company shall have power to charge for freight, towage, and transportation on such vessels, such sum or sums of money as may be from time time prescribed by the directors of said company.

SECTION 14. *And be it further enacted*, That this act shall take effect from the date of its passage.

Approved April 1, 1872.

CHAPTER 494.—*Of Canals.*

AN ACT incorporating the Maryland and Delaware Ship-Canal Company, and authorizing said company to construct a canal through the State of Delaware.

Be it enacted by the senate and house of representatives of the State of Delaware in general assembly met (two-thirds of each branch of the legislature concurring herein.)

SECTION 1. That the president and directors of the Maryland and Delaware Ship-Canal Company, a corporation created by and under an act of the general assembly of the State of Maryland, approved April 1, 1872, their associates and successors, be and are hereby created and made a corporation and body politic in law and in fact, by the name and style of "The Maryland and Delaware Ship-Canal Company," and by that name may sue and be sued, plead and be impleaded in any court of law or equity, and may also provide and establish such by-laws and regulations as may be necessary and proper for the government of said corporation and not contrary to the constitution and laws of this State or of the United States. And said company are hereby authorized to cut and make a ship-canal through the State of Delaware and thereby connect the waters of the Chesapeake and Delaware Bays, with works, locks, offices, and appurtenances that may be needful, and with all the rights and privileges belonging to such a corporation; *Provided, however*, That said canal shall start from or at some convenient point on the Delaware Bay or some of the rivers, estuaries, creeks, or arms of the same, or emptying into the same, but not above Appoquinimink Creek and run to the State line of Maryland and Delaware.

SECTION 2. That said company, by themselves or their agents, may agree with the owner or owners of any land, earth, gravel, stone, timber, or other material, or with the owner or owners of any stream or improvement which may be wanted for the proper construction or repair of said canal or any of its works, for the purchase, use, occupation, or diversion of the same; and if they cannot agree, or if any such owner or owners be an infant, married woman, *non compos mentis*, or otherwise not capable in law to contract, or absent from the State, when such property may be wanted, application may be made by said company to the superior court, if sitting in the same county, or to any judge thereof if not so sitting, and the said court or such judge

shall, upon such application, appoint five commissioners to assess the damages that such owner or owners will sustain by the use and occupation of the property by the said company, and also the benefits and advantages to accrue to such owner or owners: *Provided, however*, That a notice in writing shall have been personally served on such owner or owners at least ten days before such application of the intent of said company to make such application for the appointment of such commissioners to assess the damages which said owner or owners may sustain as aforesaid; and in case such owner be an infant, the notice shall be served on his or her guardian, if there be one, and if not, then upon the person with whom said infant may reside; and if such owner be a married woman the notice shall be served on her husband, and if such owner be *non compos mentis* the said notice shall be served upon his or her trustee, if there be one, and if there be none then upon the person with whom he or she resides, or in whose charge he or she may be, and in case of any other disability or absence of any such owner, such notice may be served upon the tenant of the land wanted or on which the material may be situated, and if there be no tenant it may be posted upon the door of the principal building thereon, or said company may, for lack of any means of serving notice as herein provided, apply to the said court, if sitting as aforesaid, or to a judge thereof in vacation, who shall make an order prescribing such notice as may be most reasonable in the particular case. And when said commissioners shall have been appointed they shall thereupon, or at any time before entering upon the land, give to the owner or owners thereof at least five days' notice in writing of the time and place of their meeting, and serve the same in the same manner prescribed for the service of notice of their appointment, and said commissioners shall be duly sworn or affirmed to perform their duties with fidelity and to the best of their skill and judgment and without fear, favor, or partiality; and said commissioners on being notified by said company shall go upon the land and assess the damages such owner or owners will sustain by the use and occupation of the property required by said company, and also the benefits and advantages to accrue to the owner or owners by the construction of said canal as a set-off to said damages, but only in extinguishment of the claim of damages and not for the actual value of the land, and after having made a just and fair offset of the advantages rising from the construction of said canal, the said commissioners shall estimate and determine what amount of damages has been or may be sustained by the said owner or owners respectively, and the said commissioners shall certify and report their finding and award to both parties; and if either party be dissatisfied with the damages so assessed such party may, on application to the prothonotary of the superior court for the county in which said lands or property is situate within thirty days after such assessment and award, sue out a writ of *ad quod damnum*, requiring the sheriff in the usual form to summon twelve impartial freeholders of the bailiwick, and when such writ shall be delivered to the sheriff he shall give at least ten day's notice to the parties named in said writ, and the service thereof shall be upon the owner or owners of the land in the manner heretofore prescribed for the service of notice of the appointment of said commissioners, and if such notice be required to be served on the said company, it may be served upon the agent or attorney of said company in this State, if any there be, and if not, then by inclosing such notice in an envelope and mailing the same, postpaid, to the "Maryland and Delaware Ship Canal Company, New York," and such notice shall state the time and place of executing said writ, and said sheriff shall cause to come upon the premises at the time appointed, twelve good, lawful, and impartial freeholders of his bailiwick, to whom he shall administer an oath or affirmation that they will well and diligently inquire concerning the matters and things in the said writ specified, and a true verdict give according to the best of their judgment and ability, and without favor or partiality to any one, and that they will perform their duty in that behalf with fidelity in all respects, and that they will well and truly assess the damages which the owner or owners will sustain by the use and occupation of the property required by the said company, and also the benefits and advantages to accrue to said owner or owners by the construction of said canal as a set-off to the said damages, but only in extinguishment of said damages and not for the actual value of the land or other property taken or required; and after having made a fair and just offset of the damages arising from the construction of said canal, they shall estimate and determine what amount of damages has been or may be sustained by the said owner or owners respectively, and their decision and report shall be final; but in case the jury cannot agree, after having been kept together a reasonable time, the sheriff may discharge the said jury and without any other writ summons another like jury, not including any of the former jury, who shall in all respects be qualified as the first one, and like proceedings shall be had as in the first, except that no notice shall be required, and in case of a second or subsequent disagreement the like proceedings shall be had until an agreement and verdict be obtained, and said commissioners shall in all cases describe the property taken or required by metes and bounds or other certain and particular description and the quality and duration of the estate or interest therein, and such valuation and ascertainment of damages, when paid or tendered to such owner or owners, his, her, or their legal representatives,

shall entitle the said company to the estate or interest therein, as if the same had been legally conveyed by the owner or owners thereof, and in case such owner or owners shall be minors, non-residents, or for any cause legally incapable of receiving or neglect or refuse to receive such damages, then the said company may deposit the said damages in the Farmers' Bank of the State of Delaware, to the credit of the said owner or owners, and subject to his, her, or their order, or the order of the court of chancery in the case of any legal incapacity of any such owner or owners to receive the same, whereupon the said company shall be entitled to have, hold, use, and enjoy the said lands, premises, or other property so required as aforesaid, for the purpose of said company; and in case of the death, refusal, or inability of any such commission to act, the said court or judge shall appoint in like manner another to fill such vacancy, and as soon after as occasion may occur. The expenses of all such proceedings shall be paid by the company, except that in the case of a writ *ad quod damnum* as herein before provided for, the party suing out such writ and obtaining a verdict less favorable than the award of the commissioners shall pay the expenses incident thereto, and should any difference or dispute arise at any time in regard to any expenses in any of the proceedings to ascertain damages, the superior court shall hear and determine the same in a summary manner. And whenever said canal shall pass or cross any road or railroad, the said company shall erect and maintain in good order such suitable swing, draw, or other bridges as may be necessary and proper for such passage, so that travel on such road or railroad may not be impeded or transportation thereon interrupted or hindered.

SECTION 3. That nothing in this act shall authorize said company to take private property for their own use without just compensation as agreed upon between the parties, or as hereinbefore provided for.

SECTION 4. That said canal shall be at least 21 feet deep from the surface level and 40 feet wide at the bottom thereof, and proper basins or turn-outs shall be constructed at convenient points to enable the largest vessels to pass each other.

SECTION 5. That the said company are hereby authorized to provide and establish a tariff of tolls for the navigation or use of said canal or any part thereof, and the same to alter at their pleasure; provided the said tolls shall not exceed 10 cents per ton.

SECTION 6. That all vessels shall be free to navigate the said canal on equal terms; and said canal when so constructed and open for navigation shall be and remain a public commercial highway, open to all vessels upon terms of the most exact equality, and no higher tolls, by any name or device whatsoever, shall be charged upon or collected from citizens of this State than are charged and paid as through tolls, excepting, however, that vessels owned by any citizen of this State and passing through only one half or less of said canal in this State shall not be charged more than 7 cents per ton, nor shall any unfavorable discrimination be made against local freights or trade by any means or device whatsoever.

SECTION 7. That there shall be three additional directors for the said corporation, all of whom shall be stockholders, and two of whom, at least, shall be resident freeholders of the State of Delaware, and all legal process and notices may be served upon any resident director, which shall be a valid service on the corporation.

SECTION 8. The said canal, when completed and in operation, shall be subject to assessment and taxation according to the law of this State.

SECTION 9. That said company may make and enforce rules for the good government of the said canal, its harbors, basins, and appurtenances, and for the general convenience of vessels; and that if any person, whether or not navigating said canal, shall willfully or negligently obstruct or impede the navigation thereof, or willfully or maliciously injure any bridge, culvert, bank, lock, weir, or other appurtenances of said canal, such person shall be deemed guilty a misdemeanor, and on conviction thereof shall be fined not less that $15 nor more than $100, and shall be responsible in damages for all damages sustained thereby besides; and if any master, shipper, or agent shall fraudulently present to the collector of tolls or other agent of the said canal company any false manifest, invoice, bill of lading, or other statement or account of cargo of any vessel passing through said canal, or give a false statement of the toll thereon, or otherwise attempt to defraud the said company in the said tolls, he shall pay to said company the full toll due and all costs in ascertaining the same, and shall also forfeit and pay double the amount thereof to any person who will sue for the same, one-half for the use of the State.

SECTION 10. That the power to revoke this act is hereby reserved to the legislature.

SECTION 11. That this act shall not be so construed as to confer any authority upon the corporation hereby created to mortgage the said canal, its real estate, works, locks, and other property within the limits of the State of Delaware, or issue bonds for the purpose of raising money until all land damages shall have been ascertained and paid in full: Provided, that nothing herein contained shall be so construed as to authorize the said corporation to issue its bonds or other evidence of indebtedness for any other purpose than the prosecution of the work for which said corporation is organized.

SECTION 12. That whatever damages that may be assessed or agreed upon by cut-

ting or digging the said canal shall be paid or tendered to be paid before actual digging or cutting commences; and in case of failure on the part of said canal company to pay or tender payment for said damages, the party so aggrieved or damaged may apply to the chancellor of this State for a writ of injunction to stay operations, who shall grant it, directed to the sheriff of the county in which said lands or canal is located.

SECTION 13. That the route of the said canal shall be located within one year from the passage of this act, and the work of construction shall be actually commenced within two years from the passage of this act, or the corporation hereby created shall thereupon terminate, and all the rights hereunder shall thereupon cease.

SECTION 14. This act shall take effect immediately.

SECTION 15. That nothing herein contained shall be so construed as to confer upon the corporation hereby created any other transportation powers than such as incidentally belong to every canal company.

Passed at Dover, March 26, 1873.

SASSAFRAS RIVER ROUTE.

UNITED STATES ENGINEER OFFICE,
Baltimore, Md., January 8, 1880.

GENERAL: In my report of November 19, 1879, relative to the Chesapeake and Delaware Ship-Canal, it was stated that for reasons therein given a survey of the Sassafras River route had not been made, but would be at once.

This survey was executed in the month of December, 1879. The estimate is herewith submitted, amounting to $8,500,000, or about $500,000 more than the similar estimate for that route based upon data derived from the report of Mr. B. H. Latrobe, a copy of which was appended to my report of November 19, 1879.

It is believed that some improvements in location have resulted from the recent survey, and more precise information obtained upon which to base the estimate.

As the Sassafras River route is preferred by many because of its being the cheapest yet estimated for, it would seem desirable also to determine the cost of enlarging and otherwise modifying the existing Chesapeake and Delaware Canal, which debouches into the Chesapeake Bay by the way of Elk River, the entrance thereto being but a few miles from that of the Sassafras. The United States has already spent about $500,000 on the Elk River route.

The maps and note-books, enumerated below, will be forwarded by express in a few days.

One sheet, map, and profile of route from the Georgetown Bridge (Sassafras) to Delaware Bay near Liston's Point. Horizontal scale, 1 inch to 1,200 feet; vertical scale, 1 inch to 60 feet.

One sheet, hydrography of Sassafras River, from Georgetown Bridge to its head. Scale, 1 inch to 400 feet.

One sheet (tracing) hydrography of Sassafras River below Georgetown (United States Coast Survey).

Two level-books and one transit-book.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Major of Engineers, Brevet-Lieutenant Colonel.

Brig. Gen. H. G. WRIGHT,
Chief of Engineers, U. S. A.

SASSAFRAS ROUTE.

Estimate of cost for a ship canal, 100 feet wide on the bottom, 26 feet below low-water, side slopes 1½ to 1, with a berm on one side 12 feet wide and 30 feet above the bottom.

Class of work.	Quantity.	Price.	Cost.
	Cubic yards.		
Excavation above high-water	20,197,398	$ 0 20	$4,039,479 60
Excavation between high and low water	2,348,888	15	352,333 20
Excavation below low-water (canal)	11,993,567	12½	1,499,195 87
Dredging in Delaware Bay	800,000	10	80,000 00
Dredging in Sassafras River above Georgetown	4,398,095	10	439,809 50
Dredging in Sassafras River and Chesapeake Bay	5,500,000	10	550,000 00
Protection walls Delaware Bay	30,000	3 00	90,000 00
Tide locks	1		229,500 00
Railroad bridges	2	90,000 00	180,000 00
Common road bridges	3	52,500 00	157,500 00
Land damages	1,440 acres.	50 00	72,000 00
Contingencies.	10 per cent.		768,981 80
Cost			$8,458,799 98